Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Federal Higher Authority subordinated to the Ministry
of Transport, Building and Urban Affairs

Investigation report 211/08

Serious marine casualty

Collision of the RoPax ferry FINNLADY with the Skandinavienkai on 16 May 2008 in Travemünde port

17 August 2009

www.bsu-bund.de

The investigation was conducted in conformity with the law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law – SUG) of 16 June 2002.

According to this, the sole objective of the investigation is to prevent future accidents and malfunctions. The investigation does not serve to ascertain fault, liability or claims.

The present report should not be used in court proceedings or proceedings of the Maritime Board. Reference is made to art. 19 para. 4 SUG.

The German text shall prevail in the interpretation of the Investigation Report.

Issued by:

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1 Summary of the marine casualty

On the evening of 16 May 2008, the ferry FINNLADY, sailing under Finnish flag, put into the Travemünde ferry port. She was operating a line service between Helsinki/Finland and Travemünde. The intention was to moor up as usual, with the stern at pier 6 of the Skandinavinkai.

The weather and visibility conditions were good, and there was a prevailing east-northeasterly wind with a force of around 3 Bft.

On board the FINNLADY were 175 passengers, 34 crew members and a Pilot. The Master, the Chief Officer and the Pilot were on the bridge. The Second Officer was standing by at the stern for the mooring manoeuvre at the mooring station. The Chief Engineer and the Second Engineer were on duty in the engine control room.

Once she had put into the port, the FINNLADY turned at around 1945[1] inside the turning basin provided. At 1946, a control failure alarm for the starboard controllable pitch propeller (CPP) system was output both on the bridge and in the engine control room. This was not initially attributed on the bridge. The ferry then shortly afterwards headed at up to 4.8 kts across the stern post towards the bridge structure at pier 6, some 5.5 cable[2] away. The Master was navigating from the port-side bridge conning position. The actual pitch of the two propellers was "Astern 2-3", corresponding to a pitch of approx. 25%. As of 1949, when the Master set the telegraphs to zero pitch in order to hold the vessel up and then to "Ahead", the pitch display for the starboard propeller still remained on "Astern". However, as the port-side propeller was set to an "Ahead" pitch, the stern of the ferry swung out to port. After a call to the engine control room, the "RE-CONNECT" button was pressed on the bridge. The steering control was also switched back to the central conning position. At 1952, the starboard propeller could be controlled again. However, by that time, there were just a few metres between the stern and the pier, meaning that, a minute later, the FINNLADY hit the pier loading bridge at a residual astern speed of 3.4 kts.

Despite the significant impact speed, nobody was injured. There was also no leakage of substances harmful to the environment.

[1] All times specified in the report refer to Central European Summer Time (CEST) = universal time (UTC) + 2 hours.
[2] One cable length equals one tenth of a nautical mile (1.852 m).

2 Scene of the accident

Type of event: Serious marine casualty, collision
Date/time: 16 May 2008, 1953
Location: Skandinavienkai, Travemünde
Latitude/longitude: φ 53°56.5'N λ 010°51.6'E

Section from nautical chart (16) 55 (INT 1362), Federal Maritime and Hydrographic Agency (BSH)

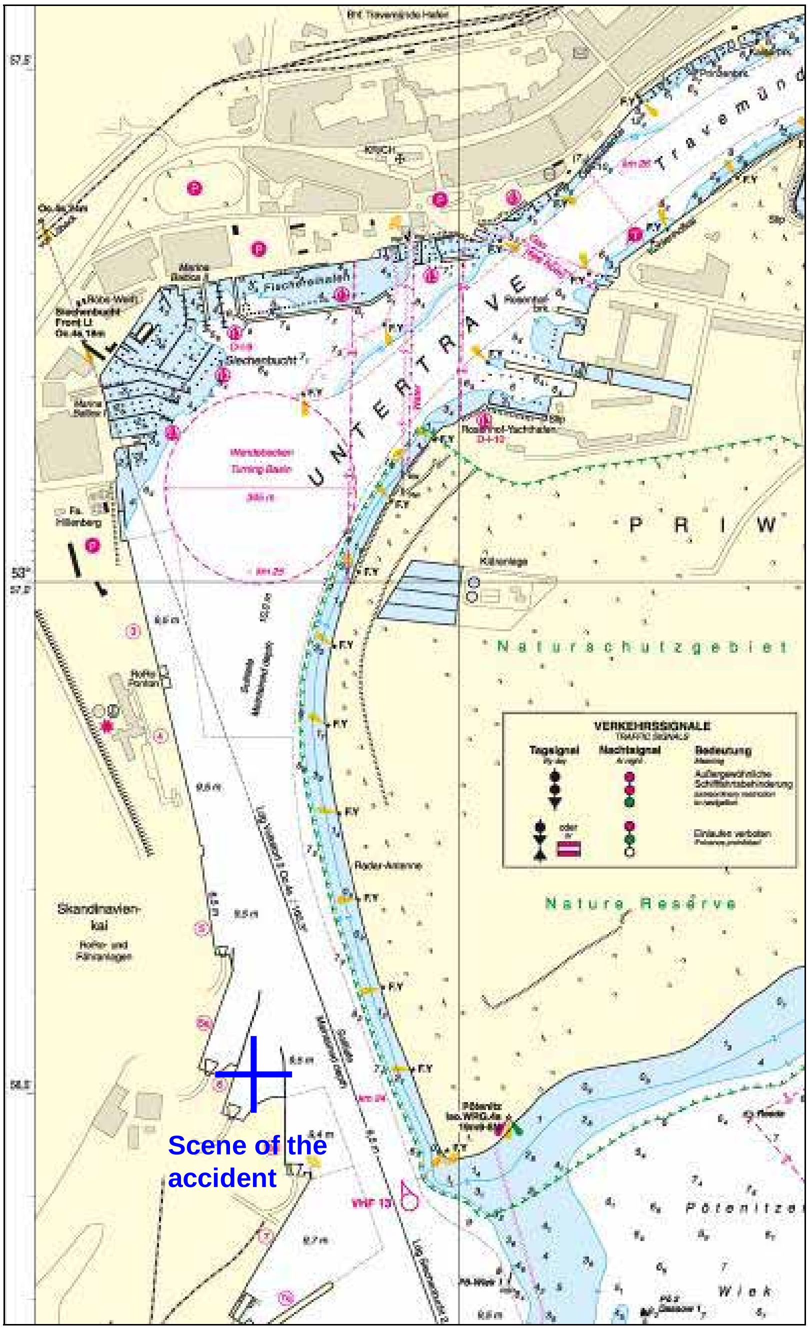


Figure 1: Nautical chart

3 Vessel particulars

3.1 Photograph of the vessel

© Hasenpusch Photo-Productions

Figure 2: Photograph of the vessel

3.2 Data

Name of the vessel:	FINNLADY
Type of vessel:	RoPax ferry
Nationality/flag:	Finland
Port of registry:	Helsinki
IMO number:	9336268
Call sign:	OJMQ
Shipping company:	Finnlines Plc
Year built:	2007
Shipyard/yard number:	Fincantieri - Cantieri Navali Italiani S.p.A / 6133
Classification society:	Det Norske Veritas
Length overall:	218.80 m
Breadth overall:	30.50 m
Gross tonnage:	45,923
Deadweight:	9,653 t
Draught at time of accident:	fore: 6.70 m, midship: 6.80 m, aft: 6.85 m
Engine rating:	41,580 kW
Main engine:	4 x Wärtsilä 9L46D
(Service) speed:	25 kts
Hull material:	Steel
Number of crew:	34 + 1 Pilot
Number of passengers:	175

4 Course of the accident

4.1 Voyage of the FINNLADY

On the evening of 16 May 2008, the ferry FINNLADY, sailing under Finnish flag, put into the Travemünde ferry port. She was operating a line service between Helsinki/Finland and Travemünde. The intention was to moor up as usual, with the stern at pier 6 of the Skandinavienkai.

The weather and visibility conditions were good, and there was a prevailing east-north-easterly wind with a force of around 3 Bft. The water level was 5.05 m with a slight outgoing current.

There were 175 passengers and 34 crew members on board the FINNLADY. The Master and the Chief Officer, as well as a Port Pilot were on the bridge. The Second Officer was standing by at the stern for the mooring manoeuvre at the mooring station. The Chief Engineer and the Second Engineer were on duty in the engine control room.

Once she had put into the port, the FINNLADY turned at around 1945 inside the turning basin provided. At 1946, a control alarm for the starboard CPP system was output both on the bridge and in the engine control room with an acoustic warning sound and illuminated indication fields. This was not initially attributed on the bridge. The ferry then shortly afterwards headed at up to 4.8 kts across the stern post towards the bridge structure at pier 6, some 5.5 kbl away. The Master was navigating using the manual helm from the port-side bridge conning position. The actual pitch of the two propellers was "Astern 2-3", corresponding to a pitch of approx. 25%. As of 1949, when the Master set the telegraph to zero pitch in order to hold the vessel up and then to "Ahead", the pitch display for the starboard propeller still remained on "Astern". However, as the port-side propeller was set to an "Ahead" pitch, the stern of the ferry swung out to port and hit a port-side fender pile. After a call to the engine control room and on the relevant advice of the Chief Engineer, the "RE-CONNECT" button was pressed on the bridge. The steering control was also switched back to the central conning position. At 1952, the starboard propeller could be controlled again. However, by that time, there were just a few metres between the stern and the pier, meaning that, a minute later, the FINNLADY hit the pier's lowerable loading bridge at a residual astern speed of 3.4 kts.

As a result of the collision, the FINNLADY's stern ramp was blocked by bent steel. The steel parts creating the blockage were burned off as of 2200. At 2340, the FINNLADY proceeded under Pilot guidance and without any technical difficulties to pier 6a.

4.2 Damage arising from the accident

4.2.1 FINNLADY

The FINNLADY showed damage on both sides in the area of the transom. On port side, the shell plating was damaged over a surface area of approx. 1 m^2 by the contact with fender piles at pier 6 (see Fig. 3).

Figure 3: Damage to the port-side shell plating of the FINNLADY

Level with the cofferdam, the plating over a surface area of approx. 2 m x 1.5 m above the water line had been ripped open (see Fig. 4).

Figure 4: Damaged cofferdam on the port side of the FINNLADY

On the lower of the two stern ramps, the flange and stiffener were damaged in the midship area (see Fig. 5).

Figure 5: Damage to the stern ramp of the FINNLADY

On the starboard side, the plating in way of water ballast tank 16C was buckled along a length of approx. 1 m (see Fig. 6).

Figure 6: Damage to the transom on the starboard side of the FINNLADY

4.2.2 Pier structure

The FINNLADY initially hit the pier fender piles, partly causing considerable deformation. Numerous rubber fenders were torn off (see Fig. 7) and pieces of concrete were knocked out in some places.

Figure 7: Damage to the fender piles

The steel structure of the foremost fender pile in front of pier 6 was damaged, whereas it could not be ruled out that the pile had been damaged prior to the accident (see Fig. 8).

Figure 8: Damage to the foremost fender pile

Several platings were partly ripped off the anchoring of the lowerable loading bridge at the pier as a result of the stern impact of the FINNLADY (see Fig. 9).

Figure 9: Damaged plating on the loading bridge

The steel substructure of the bridge was buckled (see Fig. 10). The bridge hydraulics could no longer be operated following the collision.

Figure 10: Damage to the steel substructure of the loading bridge

5 Investigation

The Federal Bureau of Maritime Casualty Investigation (BSU) began the investigation on board the FINNLADY the night of the incident. Particular attention was paid to saving the recorded information from the Voyage Data Recorder (VDR) and the recordings of the Travemünde Vessel Traffic Service (VTS). The Master was also interviewed and proved extremely cooperative.

From the very start of the investigation, close cooperation based on mutual trust was established with the shipping company and the manufacturers of individual vessel parts. During the further course of the investigation, the BSU also appointed an experienced expert on maritime engineering.

The Travemünde Waterways Police (WSP) provided the BSU with extensive photo documentation and the results of their investigations.

5.1 Surveys of the FINNLADY

5.1.1 Survey on 16 May 2008

The BSU boarded the FINNLADY via the pilot hatch 2.5 hours after the incident, while the vessel was still moored at pier 6. Following a brief discussion with the Master, the way in which to proceed was coordinated with the Travemünde WSP, who were also on the bridge. The Pilot, who had been on the bridge at the time of the incident, had already left the FINNLADY for his next duty assignment. When the BSU arrived, a new Pilot was on board to advise on the planned manoeuvring to pier 6a.

While flame-cutting work was being carried out to enable the loading ramp of the FINNLADY to be fully opened again, the BSU initiated the VDR emergency backup on the bridge. The Master had pressed the emergency button shortly after the incident but it was unclear whether the backup had been successful. To be on the safe side, another emergency backup was therefore initiated in consultation with the manufacturer, Sperry Marine. As a result of the backup, valuable information, particularly relating to the technical procedures prior to and during the collision, was obtained for the purposes of the marine casualty investigation (see 5.3.1).

When the welding work on the ramp had been successfully completed, the FINNLADY shifted to the adjacent pier 6a without any technical difficulties occurring. Once there, the passengers were then able to disembark. Despite the collision and several hours' wait before leaving the ferry, they behaved calmly and sensibly.

Once the FINNLADY had been moored up securely, the Master was interviewed again. Further extensive investigation was postponed.

5.1.2 Inspection on 17 May 2008

On the morning after the incident, BSU and Travemünde WSP boarded the vessel once again in order to add photos in daylight to the photo documentation begun the previous night. Preliminary repairs were documented on 18 May 2008 by the WSP (see Fig. 11).

Figure 11: Emergency repairs to the damaged cofferdam

5.1.3 Survey on 18 November 2008

During the investigation, it was determined that comparable technical failures had previously occurred on sister vessels of the FINNLADY, most recently on the FINNMAID. In order to discover whether a general malfunction affecting all vessels of the same build could be present, the investigation was subsequently also extended to these malfunctions, as far as they could be traced by means of reports and interviewing witnesses.

Six months after the collision, a joint inspection of the FINNLADY took place at the Skandinavienkai with representatives of the shipping company (FINNLINES, Finland) and the manufacturer of the CPP system (Rolls Royce, Sweden), conducted by the BSU. The BSU was represented by an investigation team and its expert, graduate engineer (Dipl.-Ing.) Norbert G. Erles. The Master, who had not been on board on the date of the incident, but was familiar with the FINNLADY and her sister vessels, was also available to answer any follow-up questions, as was the Chief Engineer, who had experienced the incident in the engine control room (ECR). The thorough inspection and the preliminary results were prepared for and reviewed in joint meetings attended by all participants. The investigation focused on:

- Reconstructing the technical causes of the incident, particularly the malfunction of the starboard CPP and
- Tracking general procedures on board with regard to
  - communication between the bridge and the ECR
  - dealing with alarms.

During the inspection, the VDR data evaluation results were also taken into consideration and discussed. Both the shipping company and the manufacturer of the CPP provided extensive material for the purpose of the marine casualty investigation, including further technical plans, manuals, internal shipping company reports and instructions, reports relating to checks on sister vessels of the FINNLADY and the damage and repair report of the classification society DNV.

The results of the joint survey and meetings were incorporated into the detailed expert's opinion, which was provided by the BSU's expert following the survey(see 5.4).

5.2 The vessel

The FINNLADY is the third of five RoPax ferries of the same build in the "Star" series, and was built by the Italian Fincantieri shipyard for the shipping company Finnlines. In addition to the FINNLADY, the FINNSTAR, the FINNMAID, the EUROPALINK and the NORDLINK are also in operation. All ferries were completed in 2006 and 2007.

5.2.1 Construction, propulsion system and rudder system

The FINNLADY is a double-bottom vessel, designed to carry 500 passengers. The vehicle and/or loading decks are accessible via two lowerable stern ramps (see Fig. 12).

The FINNLADY's propulsion system comprises four 4-stroke diesel engines from the manufacturer Wärtsilä, type 9L46D, with a power output of 10,395 kW at 500 rpm for each engine. Two bow thrusters each provide a rated output of 2,000 kW.

Propulsion is carried out via two contra-rotating CPPs from Rolls Royce with a revolution frequency of 150 rpm. The couplings are also from the manufacturer Rolls Royce. A Becker rudder is fitted aft of each propeller.

The FINNLADY uses low-sulphur fuel.

Figure 12: Stern view of the FINNLADY

5.2.2 Manoeuvre characteristics

The maximum speed of the FINNLADY is 25.5 kts at 124.4 rpm in ballast. According to the wheelhouse poster, the ferry requires 100 seconds to manoeuvre from "Full Ahead" to "Full Astern" and 90 seconds from "Stop" to "Full Astern". The stopping distance from the maximum speed in ballast is 967 m in 2 minutes 23 seconds. When moving astern, the FINNLADY has 100% of the power output available.

The bow thrusters each require 240 seconds to execute a 90° course alteration when operating individually and 180 seconds when both bow thrusters are operating at the same time.

During harbour mode, the maximum rudder angle is 70° (up to 9 kts). Above speed of 9 kts, the maximum rudder angle is 35°. The turning circle radius is given as 643 m over starboard under general loading condition, and the time required for this is given as 5 minutes 19 seconds at an average speed of 10 kts. The wheelhouse poster does not contain any information about turning circle manoeuvring characteristics during harbour mode.

5.2.3 Bridge and navigational equipment

The bridge wings of the FINNLADY are integrated into the wheelhouse (see Fig. 13 to 15).

Figure 13: Wheelhouse with integrated starboard wing

Figure 14: Central conning position

Figure 15: Integrated port wing

The bridge windows can be shaded with roller blinds (see Fig. 16). The sun was low at the time of the incident (sunset: 2115). The blinds had not been pulled down on the evening of the incident.

Figure 16: Bridge windows with roller blinds

The majority of work operations on board the FINNLADY are computer-monitored and can be controlled from the bridge. The overview menus on the PC screens provide a multitude of information. It is possible, for example, to access several camera angles, enabling astern visibility (see Fig. 17).

Figure 17: Transmission of several camera angles to the bridge

As on-board processes that are not critical to navigation are also monitored, alarms that are unfamiliar to nautical bridge personnel are also output, for example in the event of lift malfunctions.

Navigation is carried out on the ferry using an official Electronic Chart Display and Information System (ECDIS). In line with the regulations, a second, independent ECDIS is available as a redundant system. The ECDIS is operated with official PRIMAR nautical chart data (ENCs). The navigational equipment also includes four radar systems (two S-band and two X-band systems) with Automatic Radar Plotting Aids (ARPA), two magnetic and two gyro compasses and an Automatic Identification System (AIS). The FINNLADY is also equipped with a Voyage Data Recorder (VDR).

5.2.4 Controlling the CPP

The propeller pitch can be controlled both from the bridge and from the engine control room as well as the engine room. The panels on the bridge and in the engine control room are virtually identical with regard to the arrangement of the controls (see Fig. 18 to 21; also see pg. 6 of the enclosed expert's opinion). One major difference is in the user interface (4) "Manoeuvre Responsibility". While there are illuminated displays and acknowledge keys on the bridge, the relevant conning positions can be activated from the engine control room by means of two turn-switches.

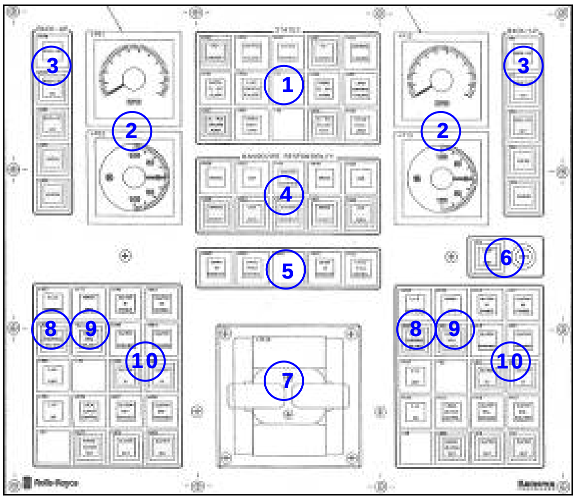


Figure 18: Panel on the bridge

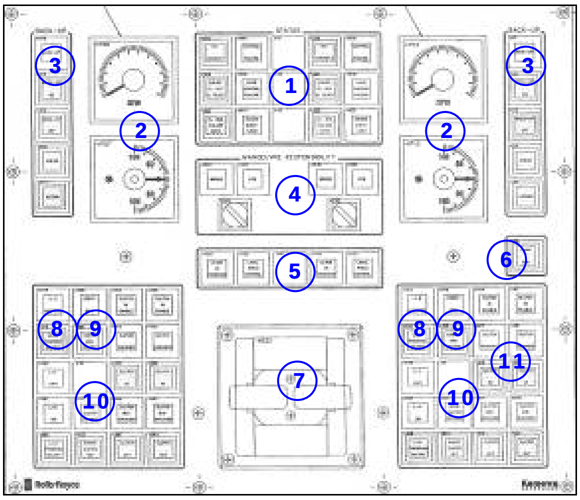


Figure 19: Panel in the ECR

Caption

1 Alarm and warning indication lamps, reset button
2 Propeller pitch and shaft rpm indicators
3 "Back-up" control
4 Manoeuvre responsibility buttons and indication lamps
5 Command mode handling
6 Dimmer knob and lamp test button
7 Thrust control levers
8 Load control buttons and indication lamps
9 Control mode selection and indication
10 Clutch control with emergency clutch out (bridge panel), separate rpm control activation and indication (ECR panel)
11 Clutch control with emergency clutch out (ECR panel only)

Figure 20: Panel on the bridge (photo)

Figure 21: Panel in the ECR (photo)

The electronic components of the main propulsion system as a whole are designed as redundant components in terms of both function and hardware. Functionality is described in more detail under 5.4 (expert's opinion).

In an emergency, the propeller pitch can also be controlled directly from the engine room. For this, a turn-switch on the CPP unit itself must be actuated (see Fig. 22).

Figure 22: CPP unit in the engine room

Activating engine room control automatically deactivates all other control and safety functions for the CPP (e.g. pitch limitations). The instructions on a sign located directly below the turn-switch describe briefly and clearly in English how the propeller pitch can be altered manually using the push buttons directly at the valves.

5.2.5 Procedural options in the event of a CPP malfunction

In the event of a fault in the CPP system, an alarm is output both on the bridge and in the ECR on the monitoring panel (see "Alarm simulation" video). The bridge panel has an indication lamp for CPP alarms ("SYSTEM WARNING", see Fig. 23), which flashes yellow three times in an alarm situation and then is permanently illuminated. Depending on which of the two propellers is affected by the malfunction, a red lamp "CONTROL FAILURE" lights up on the left-hand or right-hand side of the "SYSTEM WARNING" indicator. At the same time, an acoustic alarm (buzzer) is generated. In the default setting, the buzzer stops after six warning tones at second intervals[3]. The red button then stops flashing and remains illuminated. This default setting also applies to the engine control room panel, which, in contrast to the bridge panel, does not have a "SYSTEM WARNING" field.

When a malfunction occurs, there are two time-saving options to rectify it:

1. Press the "RE-CONNECT" button, which lights up automatically when an alarm is output and is directly adjacent to the alarm warning fields, or
2. Press the "BACK-UP" button.

[3] The setting has since been extended to 15 tones, see 7.

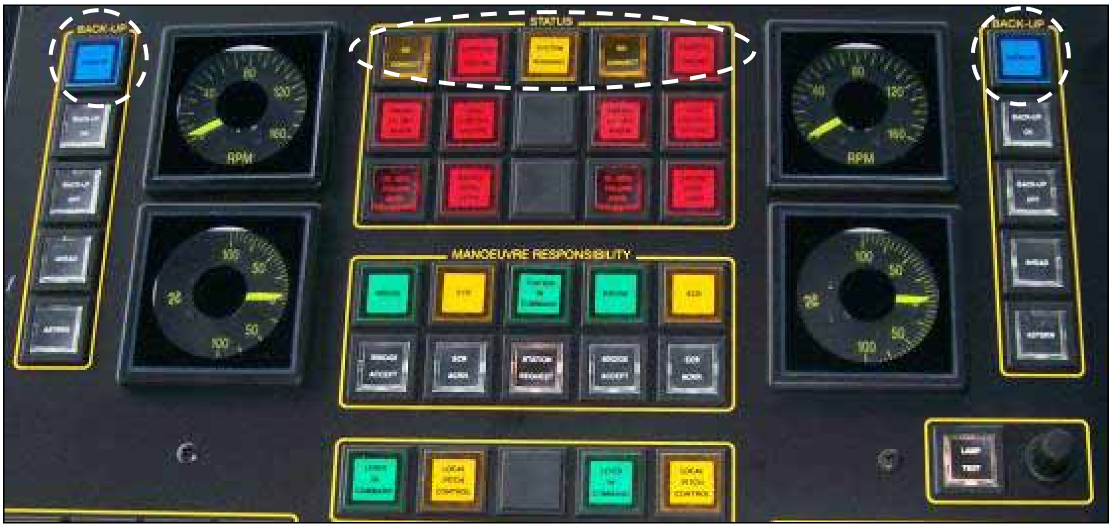


Figure 23: Section from the monitoring panel on the bridge

The manufacturer's manual for the CPP recommends, under "Actions to take at control failure alarm", first switching the command to another conning position and then resetting the system by pressing the "RE-CONNECT" button. In view of the dimensions of the wheelhouse on the FINNLADY, this procedure takes more time than pressing the button directly at the relevant active conning position.

During the inspection of the FINNLADY on 18 November 2008, the alarm for the starboard CPP system was simulated successfully several times and resolved from both the bridge and the ECR by pressing the "RE-CONNECT" button. It was not necessary to switch between the conning positions.

The faults and the alarms triggered as a result are recorded and printed out by the alarm list printer.

5.2.6 Safety management

The Finnlines shipping company operates a safety management system (SMS) in line with the stipulations of the International Safety Management (ISM) Code[4].

The ISM Code aims to create an internationally applicable standard for measures to ensure the safe operation of vessels and prevent marine pollution. The code was set out by the International Maritime Organisation (IMO) and was included in section IX of the SOLAS convention[5] in May 1994. All SOLAS member states are obliged to apply the ISM Code. The obligations resulting from the ISM Code apply to all RoPax ferries irrespective of their relevant operational area.

[4] International Management Code for the Safe Operation of Ships and for Pollution Prevention (IMO Resolution A.741(18))

[5] International Convention for the Safety of Life at Sea

At European level, Regulation (EC) No. 336/2006[6] provides for the uniform implementation of the ISM Code.

The shipping company of the FINNLADY has fulfilled its obligations resulting from the ISM Code and implemented procedures for the operation of vessels and occupational safety, as well as setting up safety barriers to counteract identified risks. The general provisions for engine room personnel include the following tasks of the Engineer on the watch[7]:

- Ensuring the functioning of the energy supply and propulsion, as well as
- Monitoring alarm and control systems[8].

Furthermore, within the context of its safety culture, the shipping company supports and promotes open communication to enable safety-related weak points to be identified.

5.2.6.1 Malfunctions in the CPP system on sister vessels

From the very start of the investigation, the BSU was aware that similar faults in the CPP system had also occurred on sister vessels of the FINNLADY without resulting in marine casualties. In the case of the FINNMAID, sporadic problems with the CPP had been occurring since the beginning of operation. Following the incident involving the FINNLADY, the same fault reoccurred on the FINNMAID on 21 October 2008 as the vessel was leaving the Skandinavienkai moving astern at an actual speed level of 1 to 1.5. The fault was rectified immediately.

5.2.6.2 Handling of the malfunction problem by the shipping company

The shipping company issued a circular to notify the Ships' commands on its fleet about possible problems with the propeller system. To identify the cause, all electrical and mechanical connections in the system, from the control lever potentiometer to the oil distribution box, were checked for faults or deviations, in cooperation with the relevant manufacturers, but without any result. The FINNMAID had already been thoroughly inspected in the dry dock prior to the incident involving the FINNLADY, but no general problems had been identified. During a subsequent check of the CAN-BUS box in the store rooms on the passenger decks of the FINNMAID, dust contamination and partially loose cabling was discovered, which might have contributed to the propeller fault. The CAN-BUS is used for electronic signal transmission between the electronic components of the main propulsion system.

[6] Regulation (EC) No. 336/2006 of the European Parliament and of the Council of 15 February 2006 on the implementation of the International Safety Management Code within the Community and repealing Council Regulation (EC) No. 3051/95

[7] Translated from the Finnish.

[8] The operational instructions have since been amended, see 7.

However, a check of the CAN-BUS box on board the FINNLADY revealed neither dirt nor inadequate cabling (see Fig. 24), which meant that the fault that occurred on the FINNLADY could not be linked to the CAN-BUS.

Figure 24: CAN-BUS box on the FINNLADY, open

Both the relevant internal shipping company reports and inspection records of the manufacturer and the classification society were made available to the BSU and its technical expert, and were taken into consideration during the reconstruction of the course of the accident.

5.3 Reconstruction of the course of the accident

Inspections of the FINNLADY, as well as the excellent cooperation of all parties involved, enabled extensive data and information evaluation for the purpose of the marine casualty investigation. The technically sound functioning of the Voyage Data Recorder in particular allowed for a complete reconstruction of the course of events.

5.3.1 Evaluation of the VDR recordings

Quick access to information stored by the VDR is essential to the investigation. Following an accident, data can be used not only to determine the cause, but also for prevention purposes, as it provides various insights and can therefore also form the basis for further technical discussion.

5.3.1.1 General problems during emergency backup

The VDR on board the FINNLADY was working perfectly. The backup of data was nevertheless not achieved without problems. As there is no uniform design standard for VDR systems, interfaces and components sometimes vary considerably depending on the manufacturer. The differences begin with the button description ("Emergency Backup", "Save", "Preserve", etc.) and continue with the arrangement of such buttons. Whereas some manufacturers enable a backup to be initiated by push buttons on the monitoring panel on the bridge, other manufacturers have refrained from the integration of their buttons into panels and have arranged the backup buttons directly on the hardware unit. The confirmation displayed after a successful backup do also vary. Depending on the display and its size, either full status messages are shown (e.g. "Emergency Backup proceeding") or indicator lights just flash. In the latter case, the only way to verify whether a backup has actually been carried out is to consult the manual. The European marine casualty investigation authorities currently list 33 Voyage Data Recorder types from 16 different manufacturers. The BSU has already pointed out the resulting difficulties at length in its 2007 Annual Report[9]. On the FINNLADY, the emergency backup could be triggered by pressing the "Save" button on the monitoring panel at the central conning position (see Fig. 25).

Figure 25: VDR user interface at the central conning position

9 See 2.8 of the 2007 Annual Report, available at http://www.bsu-bund.de.

The Master did press the button after the incident. However, due to a lack of any display, it was not possible to see at a glance whether this was sufficient to trigger a backup, and this meant that the button was actuated again following the arrival of the BSU in consultation with the manufacturer's technical service. This time, the button was held down until the green illuminated display "Recording" started to flash.

5.3.1.2 Stored VDR data of the FINNLADY

It was immediately possible to read out the emergency backup. The following information was therefore available for the purposes of the investigation:

- Dates and times
- Vessel positions
- Course (COG), heading (HDG) and speed over ground[10],
- Radar images and ECDIS recordings
- Noise and communication in the wheelhouse
- VHF radio communication
- Actual and ordered propeller pitch.

For a better overview, the variety of this information is displayed below (see Fig. 26 to 30).

[10] The speed over ground is abbreviated in German as "kn üG" in Figures 26 to 30.

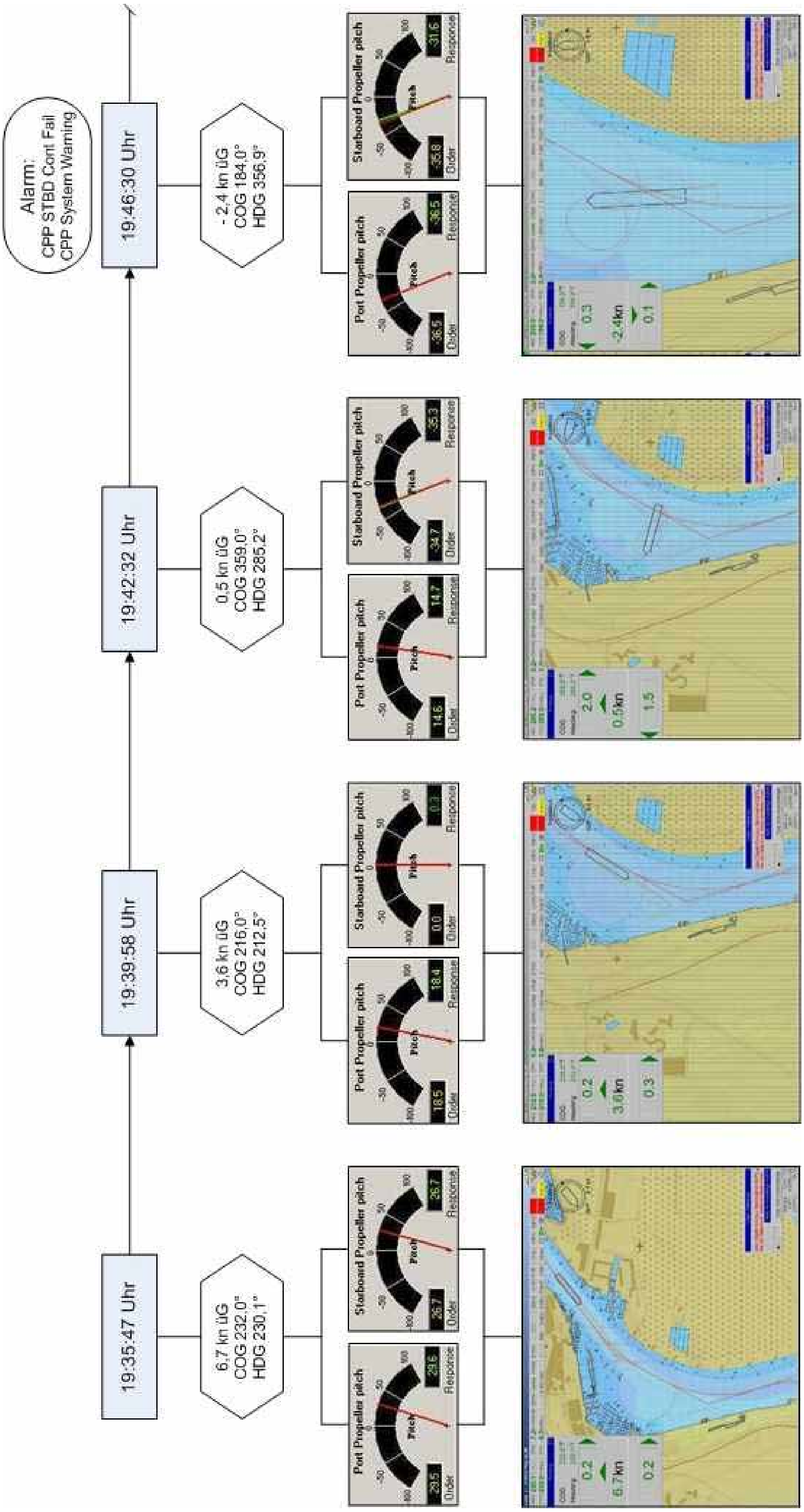


Figure 26: VDR evaluation 1935:47 to 1946:30

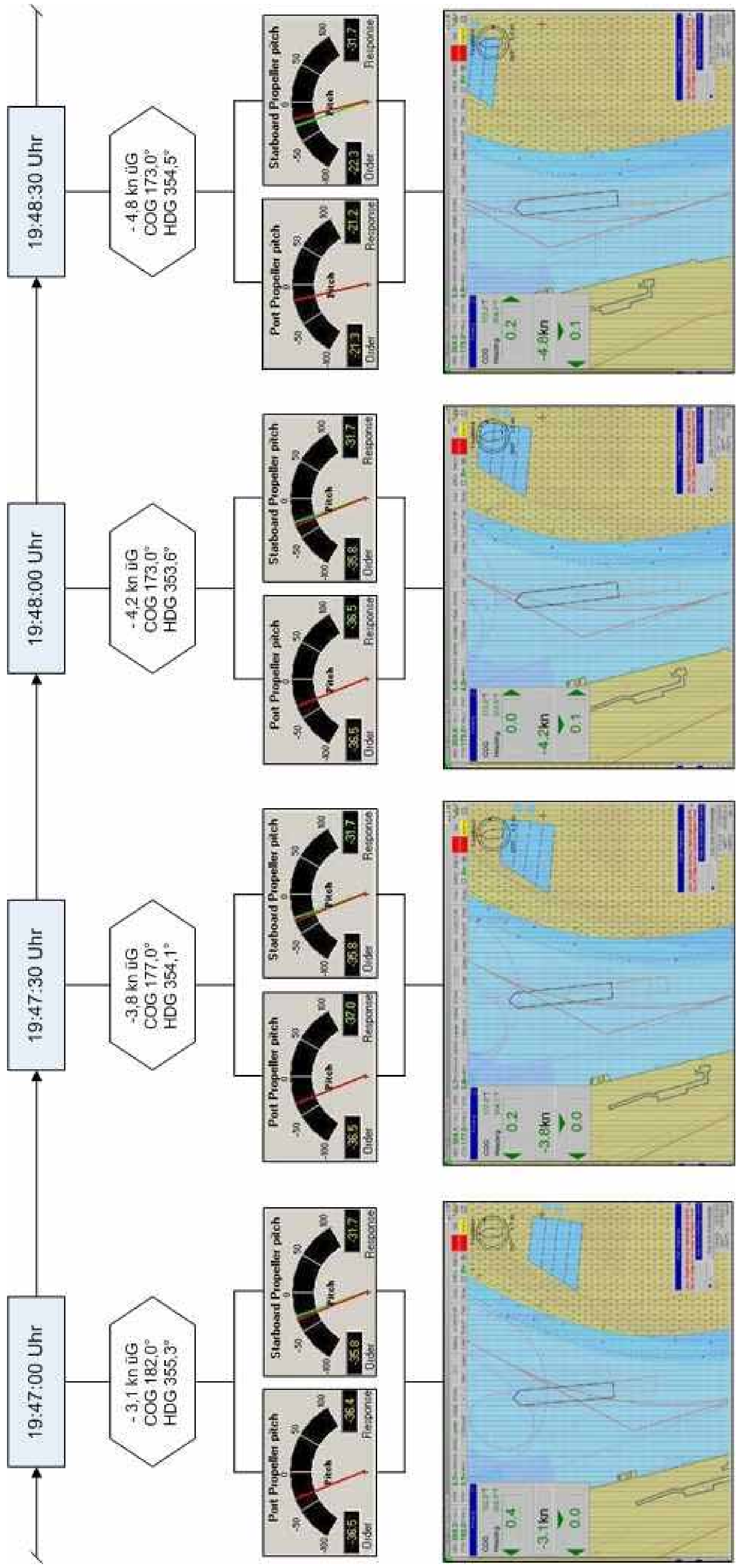


Figure 27: VDR evaluation 1947:00 to 1948:30

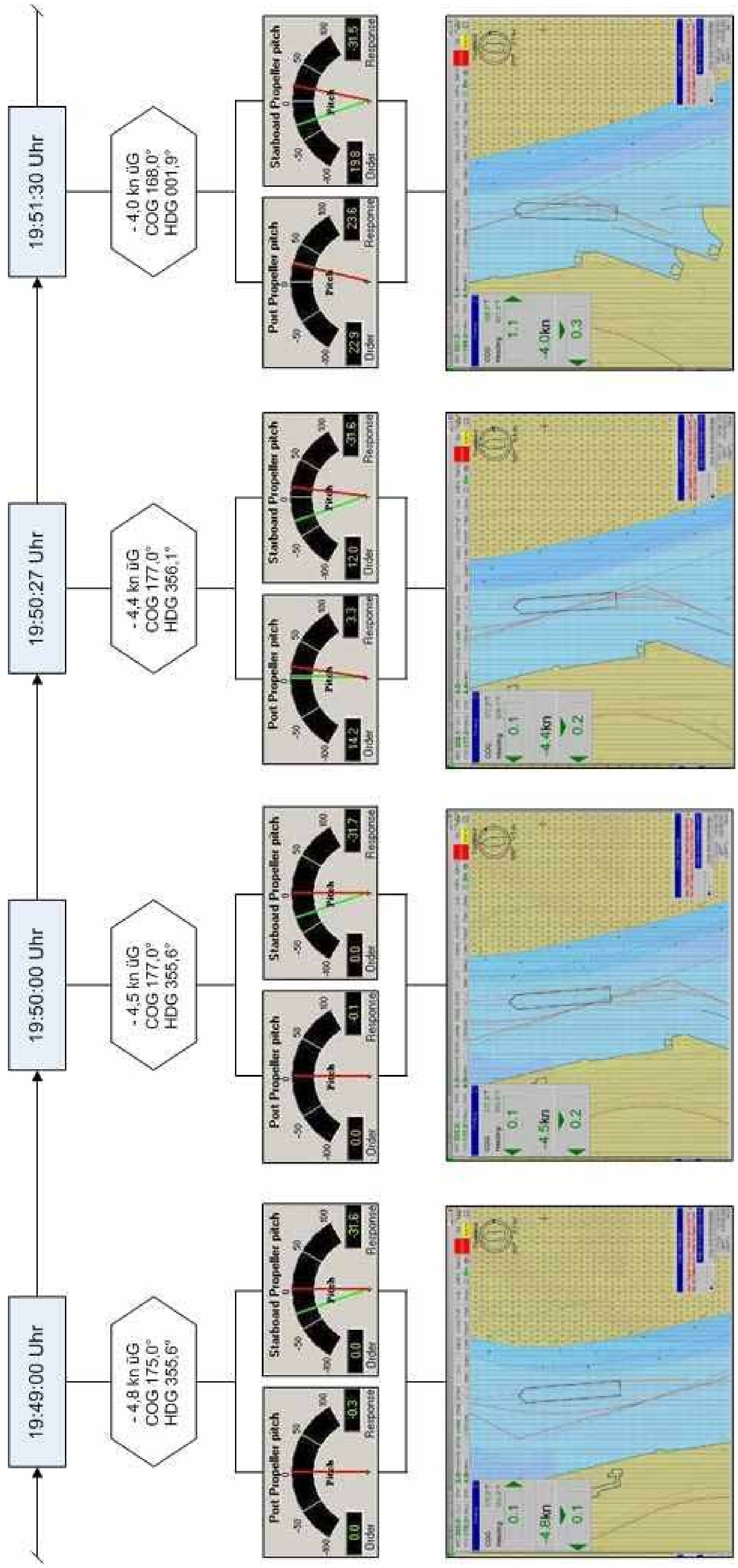


Figure 28: VDR evaluation 1949:00 to 1951:30

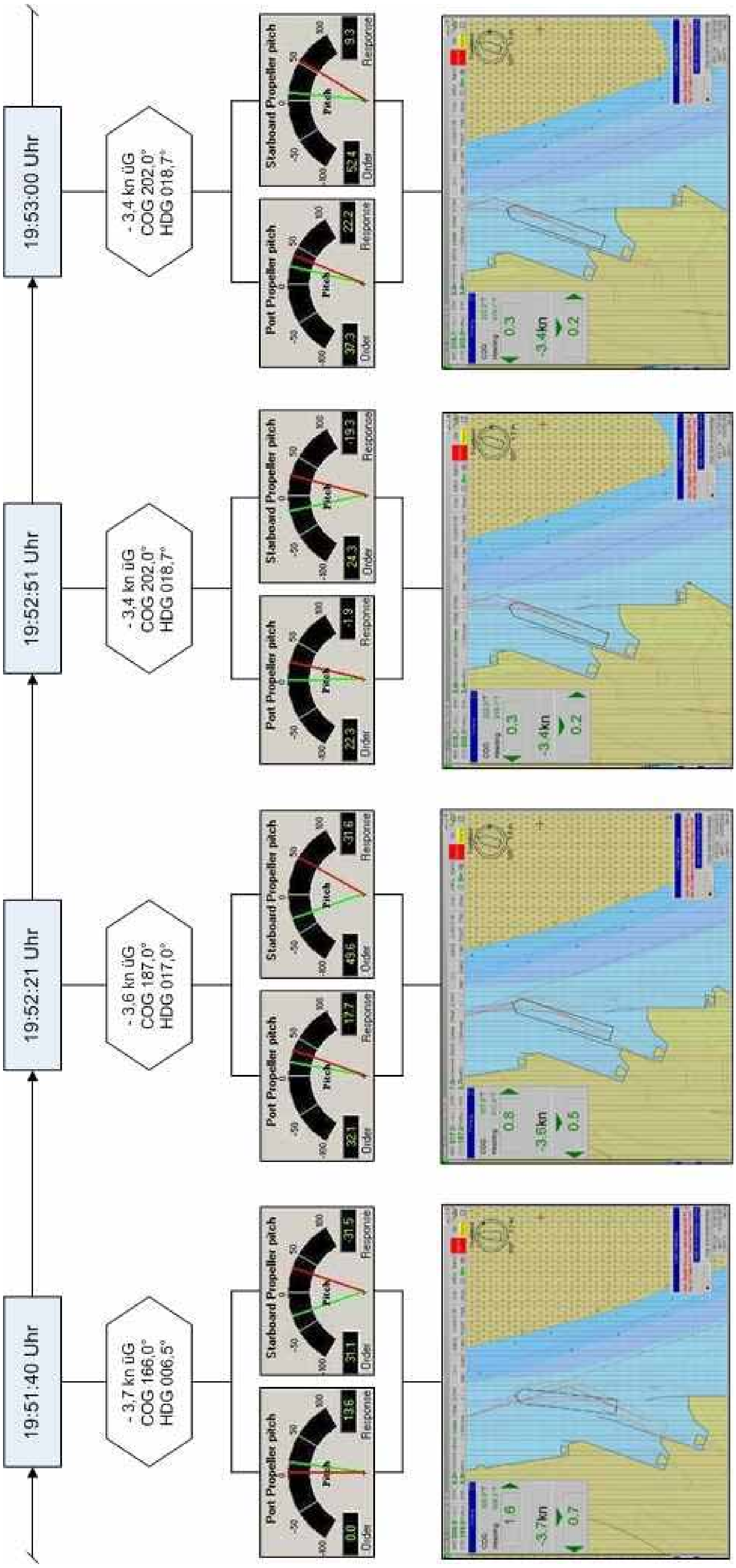


Figure 29: VDR evaluation 1951:40 to 1953:00

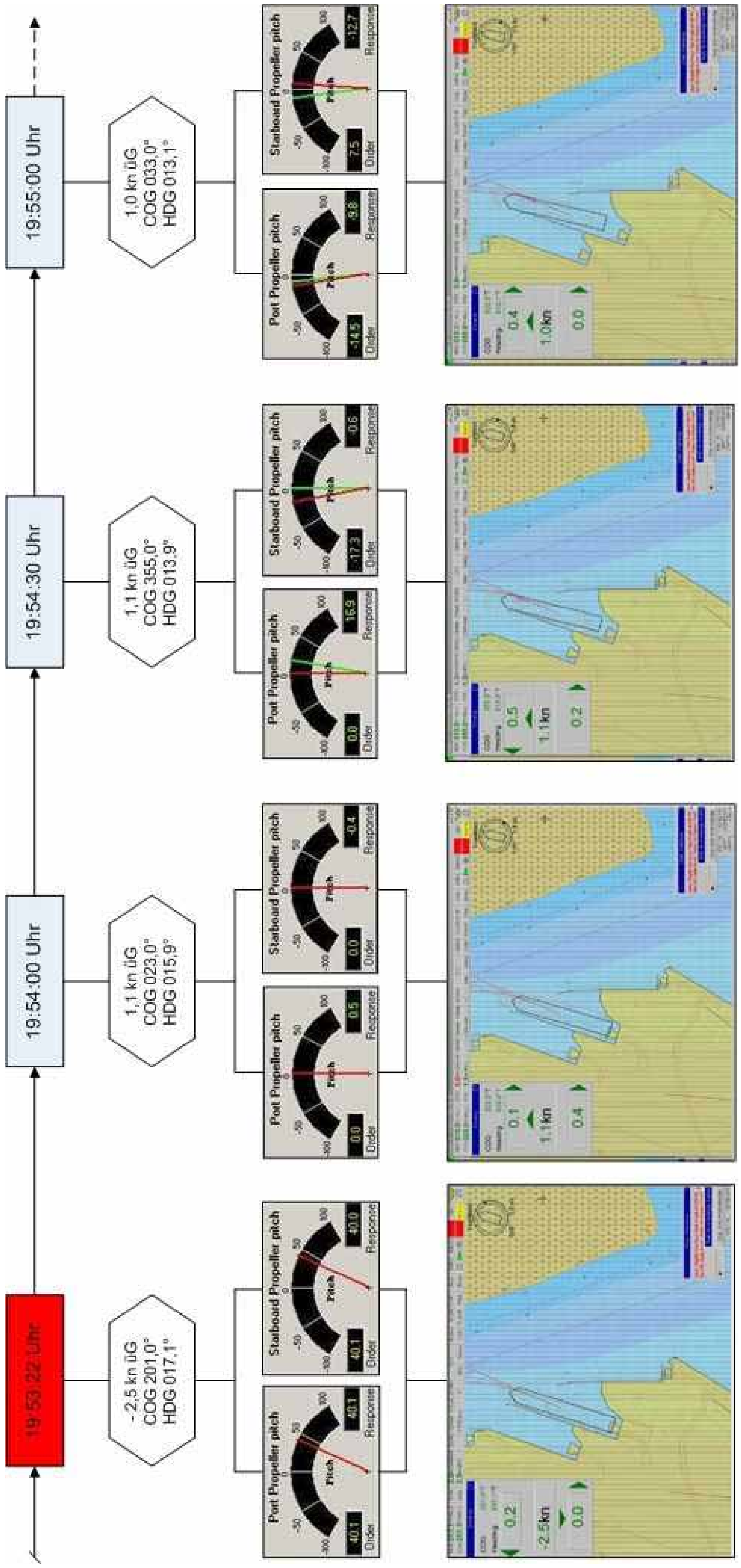


Figure 30: VDR evaluation 1953:32 to 1955:00

The above presentation of the significant VDR information shows that the starboard CPP system failed at 1946 at an actual astern pitch shortly before the completion of the turning manoeuvre, which triggered an alarm (see Fig. 26). This is verified by both the printouts of the fault printer ("CPP STBD Cont Fail"[11], "CPP System Warning") and the recorded bridge noise. From that point on, the actual pitch (-31.7) no longer corresponded to the ordered pitch (-35.8). It is important to note here that the above VDR pitch display differs considerably from the analogue pitch display in the overview panels on the bridge: whereas the digital pitch display shows exact numerical values and has two different pitch indicators (red for the ordered value and green for the actual value), the analogue pitch display on the bridge only ever shows the actual value. The Master of the FINNLADY therefore did not have detailed VDR information, but instead had to - as is customary on the bridge - monitor the displayed pitch value using the selected speed level (see Fig. 31).

Figure 31: Analogue pitch display and control lever on the bridge

Slight deviations such as the difference of 4.2% since the failure of the starboard propeller could not be identified. After all the FINNLADY did still proceed astern the next two minutes after the failure and the alarm. Not till between 1948:30 and

11 STBD = Starboard, Cont Fail = Control Failure

1950:00, the propellers were gradually adjusted to zero pitch, but the starboard pitch remained the same (see Fig. 28 and 29). Irrespective of the alarm issued, the fault relating to the starboard propeller pitch was also clearly identifiable on the analogue pitch display by 1950:00 at the latest, as the zero pitch was not realised.

When the "Ahead" order was given a few seconds later, and the starboard propeller still maintained its astern pitch, the bridge team became agitated, according to the microphone recordings. Shouts and brief communication in Finnish were recorded, as well as sounds of running. At 1952:30, the fault was rectified, as the actual pitch from this point on once again approached the ordered pitch with the usual time delay. As of 1953:00, the starboard propeller finally had an ahead pitch. However, at that time, the distance to the pier was just a few metres, the collision therefore unavoidable. The impact with the pier can be heard clearly at 1953:22 via the bridge microphones.

During the reconstruction of the course of the voyage, evaluation of the ECDIS recordings was given priority over the recorded radar images. The radar images (radius: 0.25 nm) were not very useful in view of the shadowing caused by the ferry (see Fig. 32).

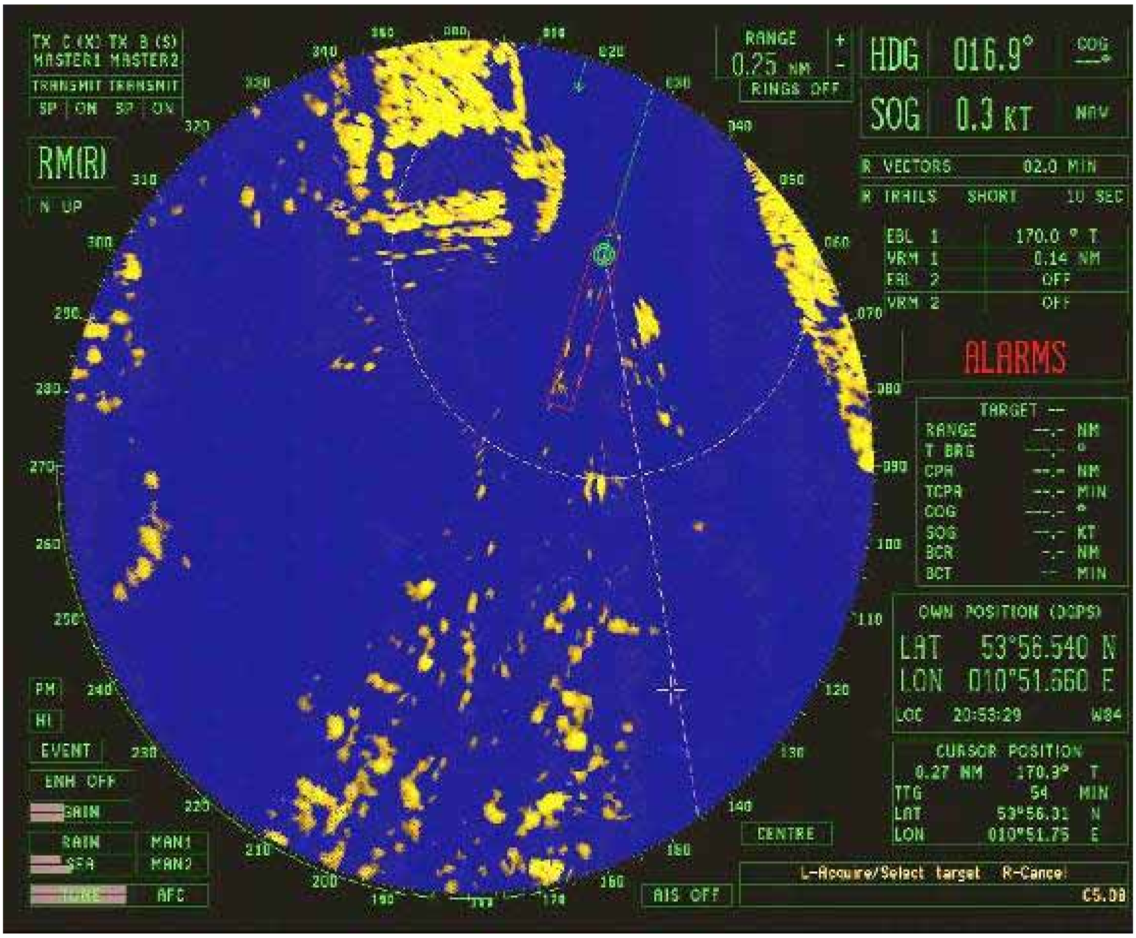


Figure 32: VDR radar image at the time of the collision

5.3.2 Evaluation of the Vessel Traffic Service recordings

The Travemünde WSP handed over to the BSU AIS recordings and recordings of VHF radio channel 13 made by the Travemünde Vessel Traffic Service (VTS). No VTS radar images were available.

5.3.2.1 AIS recordings

The AIS recordings were handed over in single-frame format, with a total of eight images for the period between 1950 and 2003. Although the FINNLADY is shown as the selected vessel on these images, no manoeuvres are stored (see Fig. 33).

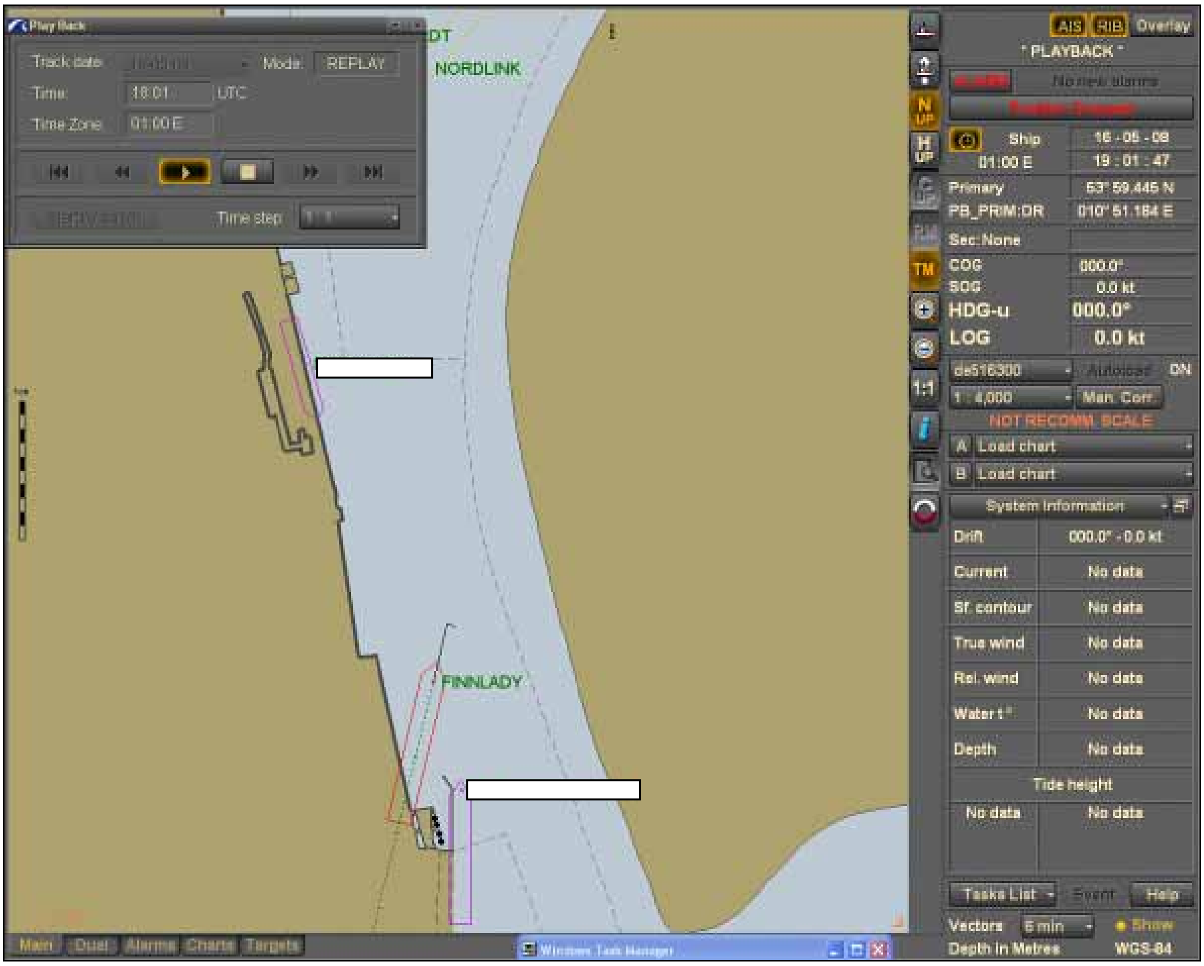


Figure 33: Vessel Traffic Service AIS recording

5.3.2.2 VHF recording

The VHF recording of channel 13 indicates that, immediately after the incident, the FINNLADY's Pilot established radio contact with the sister ferry NORDLINK, which was navigating the turning basin (Siechenbucht) (see Fig. 33). The engine problems were communicated and due care and attention was requested. The incident was also reported to the Vessel Traffic Service. When the propeller pitch was working normally again, the NORDLINK was given the all-clear via channel 13.

5.3.3 Witness reports

The Master and the Chief Engineer of the FINNLADY proved to be extremely cooperative during the marine casualty investigation and commented on the casualty event. The BSU was also subsequently provided with written accident reports by the shipping company. The Pilot involved also provided a written statement. He already knew the Master from previous pilotage assignments.

In addition to the course of the voyage described under 4.1, the following was also communicated to the BSU:

The turning manoeuvre in the turning basin had been executed from the central conning position. It was only after completion of the manoeuvre that the command was switched to the port wing, which had been checked with regard to its functionality before the Master had taken over. The ferry had then begun to proceed across the stem astern, as planned, initially at "Slow Astern" for a short time, followed by "Dead Slow Astern". At the start of the astern movement, an alarm had been issued lasting approx. 5 seconds. On the bridge, endeavours had been made, unsuccessfully, to pinpoint it. All instruments and lights reportedly seemed as usual. The evening sun had been shining brightly directly on the console. In the ECR, however, the fault had been identified but no action had been taken, as the manoeuvre responsibility had lain with the bridge team.

As she had approached the pier, the vessel had been held on course with various rudder and bow thruster manoeuvres. Problems had then arisen during the change in direction to "Slow Ahead". The speed when "swinging in" towards the pier had still been 3.5 kts, which is said to be 1.5 kts too high. When "Half Ahead" had been set, the stern had neared the pier to port side, which is why the ahead pitch of the starboard propeller was increased. However, this had shown no effect, so that the rubber guards on the fender piles had been ripped off in places with the stern edge. A call had then be made to ECR, where the advice had been to press the "RE-CONNECT" button.

While the Chief Officer pressed the "RE-CONNECT" button, the Master had switched command back to the central conning position. One or both of the measures had rectified the fault. However, there had no longer been enough time to prevent a collision.

5.4 Expert's opinion

The BSU appointed the renowned technical expert Dipl.-Ing. Norbert G. Erles to assess the complex situation. For many years, Mr Erles has headed the Damage and Repair Management department of Germanischer Lloyd and is, among other things, co-author of the definitive technical work "Handbuch Schiffsbetriebstechnik" [Ship Operating Technology Handbook].

The complete opinion is included as an appendix to this investigation report. The investigative approaches and core statements are summarised below.

5.4.1 Tasks and approach

An expert familiar with the latest on-board technology was consulted in particular due to the fact that the FINNLADY, as well as her four sister vessels of the latest build, operates a regular passenger service. As the sister vessels were also affected by propeller faults, it was important to identify and/or exclude as far as possible any general sources of failure in order to avoid future accidents. The expert's appraisal focussed on

- Checking for the existence of a systematic fault or a system fault
- Evaluating the operational performance during manoeuvres.

The expert had access to all documentation available to the BSU, and also exchanged information with the shipping company and component manufacturers. The joint inspection of the FINNLADY on 18 November 2008 formed the basis of the following findings.

5.4.2 Operating modes of the main engine

The entire propulsion system is generally run in automatic drive mode from the bridge, and both the central conning position and the wing conning positions are active. In this mode, all levers on the bridge move simultaneously. The levers in the ECR also move simultaneously but are not activated, i.e. they do not influence the main propulsion system.

The electronic components are designed as redundant components in terms of both function and hardware. This also applies to the electronic signal transmission between the components via the CAN-BUS.

Control system faults and resulting influences on the automatic drive function of the main propulsion system can be reset electronically from any active conning position by pressing the "RE-CONNECT" button. If this is not successful, pressing the "Back-up" button at the active conning positions enables one to immediately take over the pitch control of the CPP system, also accepting that automatic load control will no longer be active.

The main propulsion monitoring panels on the bridge and in the ECR are largely identical (see Fig. 18 to 21). Changing the manoeuvre responsibility by actuating the selector switches on the ECR (engine control room) panel leads to a visible (flashing) and audible alarm on the ECR monitoring panel and the three bridge conning positions. As soon as the switchover to one of the three bridge conning positions is acknowledged by pressing the flashing button, the flashing light becomes a steady light and the buzzer stops. If manoeuvre responsibility is transferred from the ECR to the bridge, it only becomes active when the corresponding flashing button is pressed. Conversely, if manoeuvre control is switched from the bridge to the engine control room, responsibility is immediately active, irrespective of whether the alarm is acknowledged on the bridge.

5.4.2.1 Manoeuvring

During general manoeuvring, which was practised on the day of the incident, the main engine ME 1 (port outside) drives the port propeller and the main engine ME 4 (starboard outside) drives the starboard propeller (see Fig. 34).

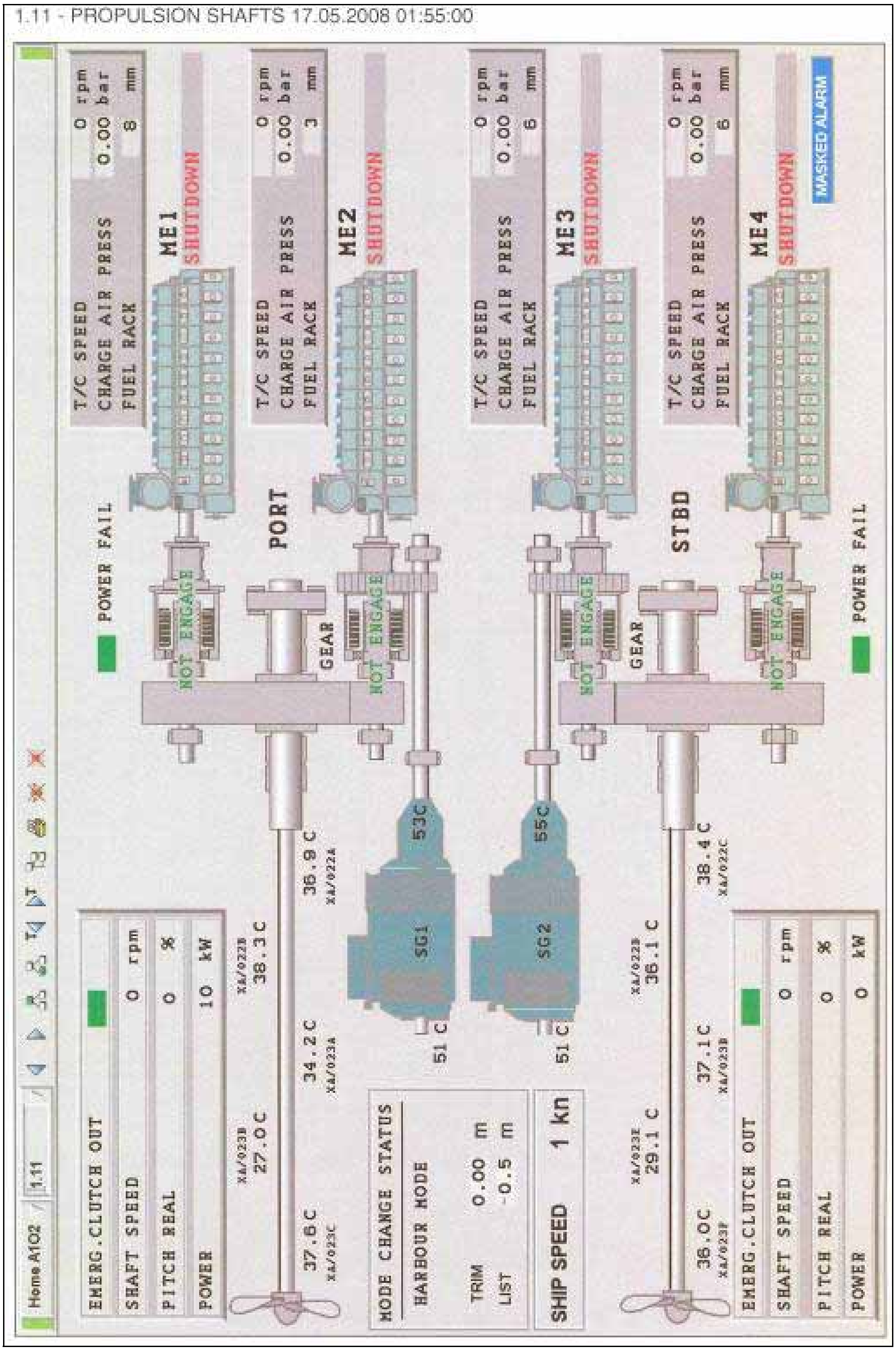


Figure 34: Arrangement of the FINNLADY's main propulsion system

Both main engines are operated in combinator mode. This means that, during manoeuvring, the propeller pitch and the associated engine speed follow a programmed combinatory curve across the entire power range, whereby the minimum rated speed is specified as 375 rpm and the speed is increased to a rated speed of 500 rpm. This applies to both ahead and astern manoeuvring, but the programmed combinator curves for "Ahead" and "Astern" are different.

During normal manoeuvring, the two internal main engines ME 2 (port side) and ME 3 (starboard side) provide the entire on-board power supply together with the auxiliary diesels. One of the two internal main engines is used directly for the electrical supply to the bow thrusters via a shaft generator, while the other internal main engine drives the second shaft generator, which feeds the port or starboard half of the electrically divided main control panel. The other half of the main control panel is fed by the auxiliary diesels.

Additional main engine operating statuses, in interaction with the two shaft generators and the two auxiliary diesels, are possible but are not generally practiced.

5.4.2.2 Sea mode

Depending on the speed requirement, all four main engines are connected to the two propeller shafts. The electrical on-board power supply is provided by the two shaft generators, which supply the divided main control panel with electrical power. The auxiliary diesels are on standby and start up automatically in the event of an on-board power failure.

5.4.2.3 Harbour mode

In harbour mode, the undivided main control panel is generally supplied with electrical power by the diesel generators.

5.4.3 Results of the survey

5.4.3.1 Bridge

Inspection of the bridge focussed largely on the equipment, i.e. the relevant main propulsion monitoring panel. The bridge conning positions were activated for a simulation of the fault and alarm signals, for comparison with those on the day of the incident. Then the fault signal "CPP STBD Cont Fail" and the alarm signal "CPP SYSTEM WARNING" were simulated at both wing conning positions for the port as well as the starboard propulsion system by issuing a manoeuvre command with the control lever. As the CPP hydraulic pumps were not in operation, corresponding fault and alarm signals were generated from system automatically. The simulation was carried out for the port and starboard propulsion systems.

The fault could be rectified in each case by pressing the "RE-CONNECT" button. As long as the control lever was not at zero thrust during this simulation, i.e. in the neutral position, the fault and alarm signals could be reproduced repeatedly and reliably.

The time it takes for the system to detect faulty functioning (deviation in the manoeuvre command compared with the actual pitch/rpm ratio) depends on various software-programmed query sequences and the specified time-related query sequence. With a deviation of 1.5% from the target value characteristic, the hydraulic control valve opens to 75% and the fault query sequence is started again. If, after querying twice, a 0.75% deviation is determined, the fault and alarm signal is activated. From identification of a deviation until the fault and alarm signal is output takes a maximum of nine seconds. This was also confirmed during the course of various simulations.

5.4.3.2 Engine control room

The survey of the ECR focussed as well largely on the main propulsion monitoring panel (see Fig. 35).

Figure 35: Drive and monitoring panel in the engine control room

After manoeuvre responsibility had been transferred from the bridge to the ECR, the same simulation tests as on the bridge were carried out for both main propulsion systems. The results were identical. In addition, the issuing alarm signals were observed on the alarm monitor in the engine control room.

A further test confirmed unequivocally that, when switching over manoeuvre responsibility from the bridge to the ECR by actuating the turn switches in the ECR, manoeuvre responsibility switches immediately to the ECR irrespective of whether or not the alarm is cancelled on the bridge. Transferring manoeuvre responsibility while the fault and alarm signals were active meant that the system faults "CPP STBD / PORT Cont Fail" and "CPP SYSTEM WARNING" could be reset electronically as soon as the "RE-CONNECT" button was pressed.

5.4.3.3 Parts of the engine room

In the engine room, the oil distribution box on the CPP system on the port and starboard side was visually inspected. No special findings or indications of maintenance and/or modification measures were determined.

The CPP system's hydraulic valve block was also visually inspected (see Fig. 36).

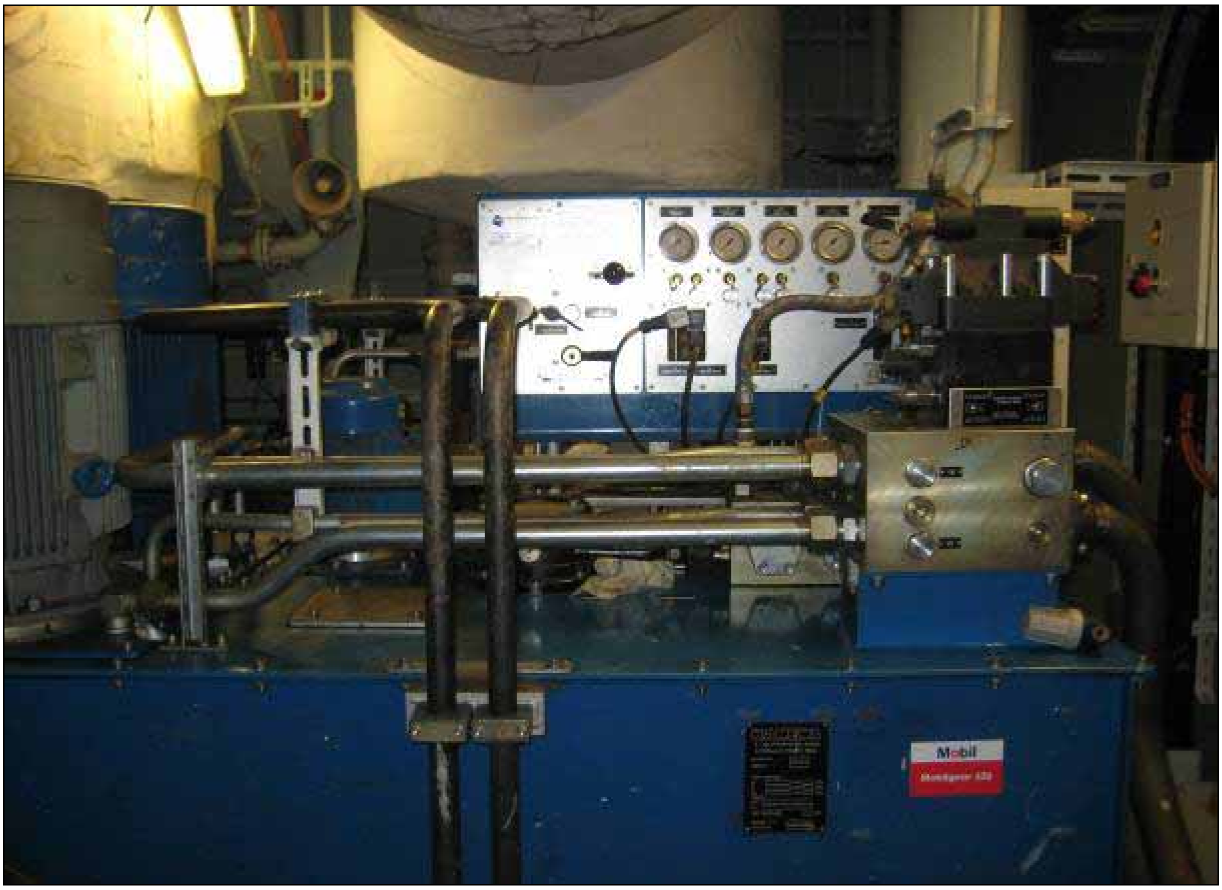


Figure 36: Hydraulic valve block

Here too, no special findings were determined. The instrument panel, the various controls and the switch devices for emergency operation of the propeller pitch adjustment function were in fault-free condition and clearly labelled.

5.4.3.4 Store room

In a store room in the passenger area on Deck 9, one of the two CAN-BUS housings was opened for inspection (see Fig. 24). The condition of the cabling and its feed-through into the housing, the way in which the cables had been secured, the strip terminals and a larger electronic module (CanMan gateway) on the mounting rails were found to be fault-free. The various strip terminals and the associated cable clips were all secure. There was no noticeable indication of thermal loading on any items of equipment.

In view of the very good condition determined, a mutual agreement was reached that there was no need to carry out the same investigation on the other side of the vessel.

5.4.4 Conclusions of the expert's opinion

5.4.4.1 General malfunction

Despite intensive endeavours on the part of the manufacturer of the main propulsion system's automatic drive function and the assistance of the technical department of the shipping company and the Ship's command, the causes of the fault that occurred on the FINNLADY could not be determined. The evaluation of the logged fault signals throughout the entire available period during which such data was stored also gave no indications of possible or actual causes.

The identical fault that occurred on the sister vessel FINNMAID does not correspond to a systematic or system fault. Irrespective of the system, in that case the causes lie in inadequate configuration during the installation of the CAN-BUS housing and its internal wiring.

5.4.4.2 Operational performance during manoeuvring

At the time of the occurrence of the fault and alarm signal described, the Master and Chief Officer were unaware of the consequences during manoeuvring. At that time, when the call to the ECR resulted in the instruction to press the "RE-CONNECT" button, no further manoeuvring could have prevented the FINNLADY from colliding with pier 6.

Both the postulated lack of familiarity with the main propulsion system and the inadequate interaction between the "bridge" and the "engine" are what caused the accident.

5.4.4.3 Recommendations

To conclude, the expert has set out the following recommendations, among others, in order to avoid such accidents in future:

- **Operational measures**
  - Ships' commands, Officers and Engineers of the FINNLADY and her sister vessels should be thoroughly familiarised with all systems required for manoeuvring, particularly with resetting the system electronically and switching to "Back-up" operating mode. The success of the training measures should be monitored.
  - As standard procedure, it should be obligatory for the Engineer responsible in the ECR during manoeuvring to take immediate action and contact the "bridge" via telephone as soon as he/she determines that manoeuvre commands are not being correctly followed by the system.

- During harbour mode, suitable sun blinds on the bridge windows should be used to ensure that, even when the sun is low, glare does not detract from the perceptibility of the fault and alarm signals.

- **Program modifications**

  - The software should be modified so that, in the event of such fault and alarm signals occurring, the activation status, i.e. flashing light and acoustic alarm, is maintained until the fault and alarm signal is reset electronically through appropriate measures.
  - The visual perceptibility of fault and alarm signals of the main propulsion monitoring panel should be improved.
  - The acoustic perceptibility of fault and alarm signals of the main propulsion monitoring panel should be strengthened, either by increasing the volume or changing the signal frequency.

- **Additional proposed measures**

  - As a preventative measure, taking into consideration the findings to date, a check of the main propulsion system's automatic drive function should be carried out on the sister vessels.
  - Because electronic system components involved in signal processing and signal forwarding, e.g. semiconductor elements, may "drift" after a while, i.e. change their characteristic values, the parameterisation data of these components should be checked, and if necessary, adjusted at specific intervals in coordination with the system manufacturer.

5.5 Summary

The investigation could not identify any reason for the failure of the starboard CPP system on the FINNLADY. However, according to current knowledge, the existence of a systematic fault or system fault can be ruled out for the “Star”- ferry line.

When a fault occurs, the system can be reset easily by pressing the "RE-CONNECT" button, if the fault that occurs is detected early on and the Ship's command, Officer or Engineer responsible for manoeuvring is familiar with this fault correction option.

On the day of the incident, the alarm was not attributed on the bridge, because the acoustic alarm had already stopped after six seconds, and the relevant flashing and/or illuminated alarm fields on the console were not noticed due to the glare caused by the setting sun. In the ECR, the alarm was correctly attributed but there was no communication with the bridge team. As a result, six minutes elapsed before the system was successfully reset. This meant that the starboard CPP was only functioning again a minute before the collision, which, given the small distance to the pier, was not at all sufficient to avoid a collision.

6 Analysis

The reason for the failure of the FINNLADY's starboard CPP system could not be determined by the shipping company, various manufacturers, the classification society and the BSU and its expert, despite extensive research and numerous technical checks. Such failures are definitely nothing unusual in the day-to-day routine on board merchant vessels. They often occur when changing direction, but can be immediately rectified with minimal action, so that no damage event occurs.

With regard to the procedures on board the FINNLADY, the BSU is concerned by the fact that, over a period of six minutes, no measures were taken to rectify the propeller failure. This is compounded by the fact that, at the time of the incident, there was a total of 210 people on board, who were luckily unharmed by the impact. The BSU's analysis of the incident therefore focuses on the organisational situation on board, which required optimisation. The improvement measures already carried out independently by the shipping company (see 7), as well as the safety recommendations (see 8), should help to ensure that comparable faults are rectified immediately in future and should also help to protect all parties involved against hazards and damage.

6.1 System knowledge and bridge resource management

Neither the Master nor the Chief Officer were sufficiently familiar with the main propulsion system to be able to immediately take the correct countermeasures once the propeller failure was detected. The bridge team was not familiar with the audible alarm and the visible alarm was not captured due to the dazzle effect resulting in the failure being perceived with significant delay. The following uncertainty about using the system apparently led to another delay, as a call was made first to the ECR for a solution to the problem. The problem was correctly rectified later than necessary by simply pressing the "RE-CONNECT" button and switching to the central conning position. In the bridge team's defence, the manufacturer's manual for CPP control expressly stipulates that, to correct the problem, it is necessary to first switch to another conning position, and it only then refers to the "RE-CONNECT" button. The bridge team followed this instruction (in spite of double-checking by phone with the ECR), and lost precious time due to the spacious wheelhouse. The sound of running recorded by the bridge microphones proves that the bridge team was definitely aware of the seriousness of the situation and believed that the system could only be reset after the switchover to another conning position. The much simpler solution of pressing the "RE-CONNECT" button in the wing was evidently not immediately identified. Such advanced system knowledge was not conveyed to optimum effect by the manufacturer's manual. Instead, further training measures or specific drills to practice this critical alarm procedure were required.

Bridge resource management (BRM), an organisational approach to improve procedures on the bridge, aims to optimise the use of resources available on the bridge. Regular intensive training of the bridge team is an essential part of BRM. Conduct and technical options in dangerous situations must be absorbed by the bridge team to such an extent that there is no room for any uncertainties, particularly when it comes to using the control and monitoring panel for the main propulsion system. It is the shipping company's task to ensure that the bridge personnel are educated and trained to the appropriate level.

Irrespective of the level of knowledge of individuals in terms of dealing with faults in the main propulsion system, it would also have been necessary on the FINNLADY to use the window blinds to counteract any glare caused by the setting sun. The video recording of a propeller alarm (cf. attachment) shows how the manufacturer has set up the alarm so that it stands out (flashing, illuminating). The fact that this clear alarm supposedly went unnoticed on the monitoring panel leads to the conclusion that the bridge wing was not optimally prepared for the mooring manoeuvre. The wing should have been darkened using blinds at least in some places.

6.2 Communication

There is a definite need for improvement with regard to communication on board. It would be excessive for the Engineer on the watch in the ECR to immediately contact the bridge every time a fault occurs. In the case of most alarms that are given, this would not help the bridge team to concentrate on its navigational duties. On the evening of the incident, however, there can have been no doubt that it was essential for the ECR to establish contact with the bridge. There was no response to the propeller failure for several minutes, even though the fault could be rectified simply with the press of a button. The failure of the starboard propeller was immediately identifiable in the ECR, in contrast to the bridge. In the ECR, the difference between the ordered and actual propeller pitch could also not be initially read on the analogue pitch display. However, as there was no glare, the alarm buttons could be clearly identified on the panel and could only lead to the conclusion that a fault had occurred in the starboard propeller. It was also possible to verify this alarm using the alarm printer logs.

Even if the assumption in the ECR had been that the alarm had been detected on the bridge, it was still foreseeable that the mooring manoeuvre might be affected by the fault. A call to double check would have been advisable as soon as it emerged that the bridge was not resetting the system as required.

Once the audible alarm had stopped and the bridge team had failed to attribute it to anything, they too should have contacted the ECR to exclude the possibility that a system important to the mooring manoeuvre was affected by the alarm.

Ultimately, on-board communication and the crew's dedication form the basis for handling safety problems on board vessels. The accident involving the FINNLADY and the discussion of this within the fleet has already led to greater awareness in this regard on the part of the ship's commands. In this context, the BSU deems the open communication that has taken place with the shipping company and the relevant parties in command as an indication that a safety culture has been established. This optimises the analysis of the course of marine casualties and is the best way to avoid future incidents of this kind through improvements.

6.3 Safety management

The shipping company's safety management system must, among other things, fulfil the prerequisites for the safe operation of vessels. Following the accident, a self-contained cause analysis was carried out immediately. Identified weaknesses in the organisation of procedures to date were rectified by means of amendments to the applicable procedural instructions and circulars to the fleet informing them of the accident (see 7).

The pertinent marine casualty revealed weaknesses with regard to the in-depth knowledge of the bridge crew in relation to dealing with faults in the CPP system. The knowledge required for rectifying faults is to be conveyed through training measures and should be refreshed and/or reinforced at regular intervals. The BSU, as well as the expert it appointed, believes that relevant training should be optimised and intensified. This is the only way to ensure that Masters, Engineers and Officers who are extremely familiar with all systems required to manoeuvre the relevant vessel are employed on board the fleet.

Furthermore, raising the awareness of the bridge team should also ensure that available sun blinds are used if required.

It is the responsibility of the Safety Management department of the shipping company to set out the necessary procedures and intervals for such training and include this in the ISM documentation and quality management for the vessels.

The shipping company has proven, by means of the improvement measures already taken - irrespective of the BSU's investigation results - and its full disclosure of internal and external analysis, that it has well functioning safety management, on board too. This assessment is confirmed by the findings as part of the basic safety management audit. The Swedish Maritime Administration (Sjöfartsverket) conducted the basic audit a year prior to the incident and subsequently determined the following in its relevant report:

> *"Overall, the crew members questioned were well motivated and interested in safety issues, so that, in our view, the company's safety management system works well in practice on the vessel."*

The audit was carried out on the FINNLADY under the same ship's command as on the day of the accident.

6.4 Summary

Ultimately, the investigation has so far ruled out the possibility of a systematic fault of system fault affecting the FINNLADY or even the build series. It will only be possible to determine this if a check of the main propulsion system's automatic drive function on all ferries of the same build produces no further findings.

During the investigation, thanks to intensive cooperation with the crew, the shipping company, the manufacturers and the external expert, the BSU was able to fully implement the safety partnership propagated by the Maritime Safety Investigation Law (SUG). Although the actual cause of the CPP fault remains unclear, it was nevertheless possible, through numerous shipping company improvement measures, to increase the safety standard not only on the FINNLADY, but also in the rest of the fleet.

7 Action taken

The shipping company informed the Ships' commands of its fleet by e-mail on 21 May 2008 about the accident involving the FINNLADY and gave the following instructions:

> *"Communicate with the bridge upon noticing that a critical alarm, such as the "Control Failure Alarm", is not resetted from the bridge."*

This passage was later included with the same wording as an addition to the ISM manual "Shipping routines, engine - general information".

Internal ISM reports by the safety warden stipulate that this type of critical alarm should generally continue to sound until it is cancelled.

Extensive technical checks were arranged on both the FINNLADY and the FINNMAID. These were carried out by the classification society and the manufacturer Rolls Royce.

The shipping company also arranged for the acoustic "Control Failure" alarm to be extended from 6 to 15 seconds, corresponding to the maximum system value.

On the FINNLADY, the hydraulic pressure of the CCP starboard unit was increased from 58 bar to 62 bar. The tests carried out prior to this increase did not lead to a renewed occurrence of the propeller fault.

8 Safety recommendations

The following safety recommendations shall not create a presumption of blame or liability, neither by form, number nor order.

8.1 Shipping company of the FINNLADY

The Federal Bureau of Maritime Casualty Investigation (BSU) recommends the shipping company of FINNLADY to familiarize the vessel commands, officers and engineers in detail with all systems required for manoeuvring the vessel. Success and sustainability of such training measures should be regularly checked in adequate manner.

8.2 Commands of seagoing vessels

The Federal Bureau of Maritime Casualty Investigation (BSU) recommends commands of seagoing vessels to ensure, for instance by use of window blinds, that the alarms in control and monitoring panels can be visually perceived during the complete voyage without delay.

8.3 Manufacturer of the CPP System

The Federal Bureau of Maritime Casualty Investigation (BSU) recommends the manufacturer of the FINNLADY's CPP system to ensure that the audible alarm sounding at a malfunction of the system is not automatically cancelled but is instead sounding without time limit. A constantly sounding alarm would draw the attention of the bridge team to the fact that the malfunction directly affects the ships safety and observation is hence imparative. It is generally recommended to reduce the number of alarms on the bridge to the absolute minimum in order to avoid confusion of the bridge team in dealing with a variety of alarms and distinguishing important alarms from less important.

Furthermore it is recommended to revise the manual for alarm handling. Uncomplicated measures, such as resetting the system by pressing the „RE-CONNECT“ button, should always be given priority before other handling options in the instructions for rectifying malfunctions.

9 Sources

- Reports and interviews:
  - Witnesses: Reports of two vessel commands of FINNLADY (master at the time of the accident as well as master at the time of the subsequent survey), of the Chief Officer, the Chief Engineer as well as the Pilot
  - Other persons involved: shipping company, manufacturer of the CPP system, manufacturer of the main propulsion system, operation company of the Skandinavienkai
- Ship's documents and certificates: Minimum Safe Manning Certificate, crew list, International Ship Security Certificate, Certificate of Compliance for the VDR, Passenger Ship Safety Certificate
- Extracts of the bridge log-book and bell book
- Wheelhouse poster and pilot card
- General arrangement plan
- List of navigational equipment
- Recordings of the VDR
- Recordings of the alarm printer in the ECR
- Layout plans of the main propulsion system and the power supply system
- Surveys carried out by the BSU
- Opinion by the appointed expert
- Investigation results of the waterway police
- Shipping Police Approval issued by the Waterways and Shipping Office Lübeck
- Port Order issued by the Free and Hanseatic City of Lübeck
- Photo documentation
- Questionnaire filled in by the shipping company
- ISM on-board documentation of the shipping company: general handbook, instructions ships routine - engine, ISM- deviation reports
- Internal correspondence of the shipping company
- Handbook, service reports and technical layouts of the manufacturers of the CPP system
- Survey statement and damage report of the classification society
- Shipping company magazine „Full ahead“, issue 2/2006

- *Expert Opinion* -

Establishment of the technical causes of the fault within the starboard propulsion system of the RoPax ferry FINNLADY and the subsequent collision with docking pier 6 at Travemünde ferry port

Expert Opinion No. 02-2008 Er Version A

Client:	Bundesstelle für Seeunfalluntersuchung Bernhard-Nocht-Str. 78 20359 Hamburg Date commissioned: 2008-11-06
Contractor/ expert in charge:	Norbert G. Erles Dipl.-Ingenieur Marine Engineer

This report comprises
37 pages, including appendix

Flensburg

2008-12-18

Table of content

1. GENERAL

1.1 Commissioning

With the contract dated 2008-11-06, the expert in charge was appointed by the client Bundesstelle für Seeunfall-untersuchung [Federal Bureau of Maritime Casualty Investigation] in Hamburg to draw up a written report on the technical causes of the fault within the starboard propulsion system of the RoPax ferry FINNLADY on 16.05.2008 at Travemünde port.

1.2 Assignment

The expert opinion should be drawn up on the basis of the documents handed over upon conclusion of the contract (listed under Chapter 1.6) and taking into consideration the results and findings of at least one joint inspection and survey of the relevant equipment installed on board. This on-board inspection should be carried out in the presence of representatives of the shipping company, the vessel's command and the relevant component suppliers or component manufacturers.

If it is deemed necessary that further documents be made available, these should be requested either from the shipping company or the manufacturers.

After examination of the documents handed over by the BSU when the contract was awarded, two focal points for investigation were determined:

- Existence of a systematic or system fault?
- Operational behaviour during manoeuvring

The written expert opinion should be taken into consideration as expertise in the BSU's Investigation Report.

1.3 Object description

MS FINNLADY	(Vessel particulars from the WSP's [water police] record and according to on-board data)
Owner/operator	Finnlines Plc, Helsinki – Finland
Type	RoPax
Shipyard/yard no.	Finncantieri Castellamare Shipyard, Ancona, Italy, new vessel no. 6133
Year built/handover	02.2007
US/IMO no.	O J M Q/ 9336268
Flag/port of registry	Finland/Helsinki
Classification	Det Norske Veritas
Length o.a.	217.6 m
Breadth	30.5 m
Draft	6.7 m fore – 6.85 m aft
Gross tonnage	45,923
Net tonnage	24,006
Propulsion system	4 x diesel engines, 4-stroke, highly supercharged with intercooling

Engine type/manufacturer	4 x 9L46D – manufacturer: Wärtsilä Finland
Propulsion power	4 x 10,395 kW at 500 rpm
Propellers	2 controllable pitch propellers, contra-rotating, 150 rpm
Bow thrusters	*no data available*
Main Propeller Control System	Manufacturer: Rolls-Royce AB, Kristinehamn, Sweden
Sister vessels of identical design	NB 6123 MS FINNSTAR NB 6124 EUROLINK NB 6125 FINNMAID NB 6134 NORLINK

1.4 Damage history

On Friday, 16 May 2008, the MS FINNLADY arrived from a seaward direction at Travemünde ferry port, intending to reverse moor at docking pier 6. The vessel was travelling ahead under pilot guidance at a speed of around 6.7 kn. The main propeller control system had been switched to bridge mode, i.e. the central bridge conning position and the two conning positions at the bridge wings were active. On reaching the turning area, the starboard propeller was ordered from a FULL AHEAD manoeuvre to FULL ASTERN in order to manoeuvre the vessel backwards some 800 m to docking pier 6.

The astern manoeuvre was, according to a WSP maritime casualty notice, carried out by the captain [...][1] and the chief officer [...] from the port-side bridge conning position, under pilot guidance [...]. The following details are based on the diagrammatic information taken from the electronic nautical chart system (ECDIS) (see Chapter 5.1). The specified times are UTC + 2 hours. As no manoeuvre printer data is available, the manoeuvre commands are derived from the ECDIS charts. As the ECDIS charts do not correspond directly with the individual manoeuvre commands, the derived times are inevitably shorter compared with the manoeuvre commands and therefore appear to be more positive.

Supported by corresponding rudder positions, the vessel began to turn across the starboard bow, while at the same time, the speed was reduced from around + 3.6 kn to zero, followed by astern manoeuvring at a speed of up to -4.8 kn. Turning and moving astern until the specified speed was reached took 09:02 minutes (from 19:39:58 until 19:49:00). At 19:49:00, the TARGET value for the port and starboard propeller pitch was set to 0 pitch. At this point, the port pitch was actually at 0, but the starboard pitch was still on FULL ASTERN.

At the same time, the TARGET value for both propellers was changed to a FULL AHEAD manoeuvre to stop the astern movement of the vessel. The port-side system followed the manoeuvre command, but the pitch of the starboard-side system was still set to a FULL ASTERN pitch. It was only after 19:53:00 that the pitch of the starboard propeller began to move towards AHEAD and the ordered manoeuvre FULL AHEAD pitch was reached at 19:53:32.

[1] All deletions of personal information and confidential statements by BSU.

The system time of the fault printer was 3 hours "ahead" of the ECDIS system time on 16.05.2008. In order to make time comparison easier, the times given below from the fault printer have been readjusted back to ECDIS system time.

At 19:46:30, the fault signal "CPP STBD CONT FAIL (Failure)" – measuring point (MP): P06 XS14013B and the alarm signal "CPP SYSTEM WARNING (Alarm)" - MP: P06 XS14015 was printed at the system fault printer. Both the fault signal and the alarm signal were deactivated by the system simultaneously at 18:09:18, i.e. after 22:48 minutes (see Chapter 5.2).

1.5 Operating modes of the main propulsion system

The entire propulsion system is usually run in automatic mode (main propeller control system) from the bridge, whereby both the central conning position (Figures 7 and 8) and the two wing conning positions (Figures 1-6) are active. In this mode, all levers (7) on the bridge move simultaneously. The levers (7) in the engine control room also move simultaneously but are not activated, i.e. they do not influence the main propulsion system.

The electronic components are designed as redundant components in terms of both function and hardware. This also applies to the electronic signal forwarding between the components via the CAN bus.

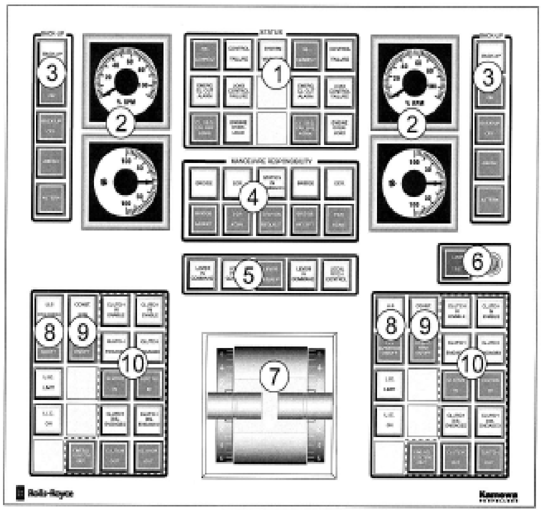
Faults in the control system and resulting influences to the main propeller control system of the main propulsion system can be reset electronically from any active conning position by pressing the "Re-connect" button (1) (arranged on the main propulsion monitoring panel) (Figures 2 and 3). This deactivates the fault and alarm signals.

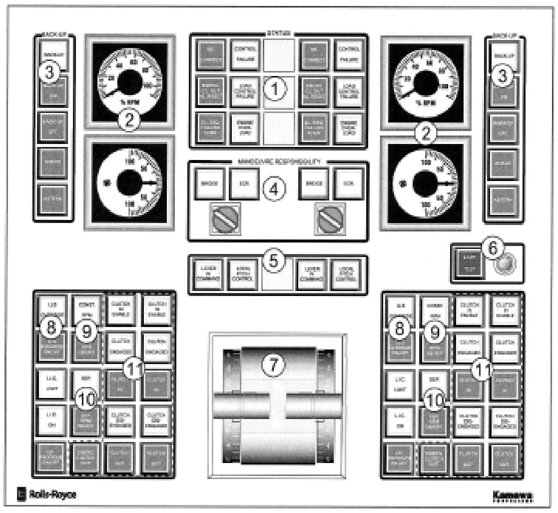
If this is not successful, pressing the "Back-up" button (3) on the main propulsion monitoring panel at the active conning positions enables you to immediately take over the pitch control of the CPP system (Figure 5), also accepting that the function of the “automatic load control” will no longer be active. The status of the automatic mode is reduced to the status of a remote control function of the main propulsion system (non-follow-up type). When an overload situation is reported (alarm signal lights up on the control panel), the operating personnel must intervene manually and carry out an appropriate power reduction (reducing rpm and pitch) (Figure 4). This system has an independent electrical supply and is therefore immediately fully functional even in the event of a real fault in the main propeller control system.

The main propulsion monitoring panels on the bridge and in the ECR (Figures 9 - 11) are largely identical. They generally only differ in the "Manoeuvre Responsibility" (4) field. On the bridge, there are only illuminated displays and cancellation keys, whereas in the ECR (4), there are two selector switches, which are used to activate "manoeuvre responsibility", i.e. the relevant conning positions (Figure 11). Changing the responsibility of a conning position can only be carried out from this panel and leads to a visual (flashing of the corresponding button on the panel) and audible alarm (buzzer) on the main propulsion monitoring panel in the ECR and at the three bridge conning positions (central conning position and port and starboard wing conning positions). As soon as the switchover to one of the three bridge conning positions has been acknowledged by pressing the flashing button, the flashing light becomes a steady light and the buzzer stops.

If manoeuvre responsibility is transferred from the ECR (4) to the bridge, it only becomes active when the corresponding (flashing) button is pressed. Conversely, if manoeuvre responsibility is switched from the bridge to the engine control room, responsibility is immediately active, irrespective of whether or not the visual and audible alarm is cancelled on the bridge.

Overview of the arrangement of the controls on the main propulsion monitoring panel:
(including caption)





Main propulsion monitoring panel – "bridge"   Main propulsion monitoring panel – "ECR"
(Source: Rolls-Royce User's Manual, Document No. 51191 - E - Rev. B)

1 Alarm and warning indication lamps and reset button
2 Propeller pitch and shaft rpm indicators
3 "Back-up" control
4 Manoeuvre responsibility buttons and indication lamps
5 Command mode handling
6 Dimmer knob and lamp test button
7 Thrust control levers
8 Load control buttons and indication lamps
9 Control mode selection and indication

10 Clutch control with emergency clutch out

10 Separate rpm control activation and indication
11 Clutch control with emergency clutch out

1.5.1 Manoeuvring

During normal manoeuvring, which was also practiced on 16.05.2008, the main engine 1 (port outside) drives the port propeller and the main engine 4 (starboard outside) drives the starboard propeller. Both main engines are operated in combinator mode. This means that, during manoeuvring, the propeller pitch and the associated engine speed follow a programmed combinator curve across the entire power range, whereby the minimum speed is specified as 375 rpm and the speed is increased to the rated speed of 500 rpm. This applies to both AHEAD and ASTERN manoeuvring, but the programmed combinator curves for AHEAD and ASTERN are different.

During normal manoeuvring, the two internal main engines 2 (port side) and 3 (starboard side) provide the entire on-board power supply together with the auxiliary diesels. One of the two internal main engines is used directly for the electrical supply to the bow thrusters via a shaft generator, while the other internal main engine drives the other shaft generator, which feeds the port or starboard half of the electrically divided main switchboard, depending on whether main engine 2 or main engine 3 carries out the supply. The other half of the main control panel in each case is fed by the auxiliary diesels.

A theoretically possible alternative is to operate the main engines in so-called constant-speed mode. In this case, the main engines are operated at their rated speed of 500 rpm and the manoeuvre stages are realised exclusively by adjusting the propeller pitch. However, this alternative should not be selected during normal manoeuvring.

Additional main engine operating statuses, in interaction with the two shaft generators and the auxiliary diesels, are possible but are not generally practiced.

1.5.2 Sea mode

Depending on the speed demand, all four main engines are connected to the two propeller shafts. The electrical on-board power supply is provided by the two shaft generators, which supply the divided main switchboard with electrical power. The auxiliary diesels are on standby and start up automatically in the event of an on-board power failure.

1.5.3 Port mode

In port mode, the undivided main switchboard is supplied with electrical power either by a shaft generator (main engines 1 - 4) or by the auxiliary diesels.

1.6 Available documents

1.6.1 Copies handed over by the BSU on 2008-10-22

- Maritime casualty notice of the WSP-Revier Lübeck Travemünde (VG / 275561 / 2008)
- Extracts from the ECDIS for the period 19:35:47 to 19:55:00 on 2008-05-16
- Extract from the engine log book dated 2008-05-16
- Extract – Chapter 6.2 Control Failure Alarm – from the RR User's Manual - Main Propeller Control System Rev. b
- Extract from the fault printer (alarm list) during the period in question
- Product description for Wärtsilä 46 - Technology Review

1.6.2 Copies handed over by Finnlines during the on-board inspection on 2008-11-18

- Rolls-Royce Combinator Diagram - Remote Control System No. 156529, mod. B
- Extract – Chapter 2.1 Manoeuvre Equipment – from the RR User's Manual - Main Propeller Control System Rev. b including 5 pages of detailed drawings

- Internal vessel report dated 2008-05-16 (in Finnish)
- Survey Statement concerning damage and repair surveys conducted by Det Norske Veritas
- Internal circular letter from Finnlines to the commanding staff of the vessels of the Finnlines fleet
- MS FINNLADY captain's instruction to the RR engineer to extend the audible warning time on the bridge from approx. 5 sec to 15 sec
- BSU questionnaires completed by the vessel command (basic data)
- Completed BSU Sea/Marine Accident Report Form
- Report on checks carried out on the sister vessel MS FINNMAID (in Finnish)

1.6.3 From Rolls-Royce after 2008-11-18

- Rolls-Royce User's Manual - Main Propeller Control System - Twin propellers with controllable pitch, Document 51191 - E - Rev. b (full brochure)
- RR Service Report No. 77037 (25.05. - 27.05.2008)
- RR Service Report No. 303074 dated 29.11.2008 including the parameter lists / calibration lists for current settings on the port and starboard main propeller control system
- RR drawings (Rev. C)
  - 140185 Shafting arrangement
  - 154620 Hub assembly (3 pages)
  - 214070 OD-box assembly (3 pages)
- RR System Description - pages 26 to 30 (of 126)
- RR email to Finnlines: Checking of the other sister vessels by a RR engineer

1.7 Abbreviations

BSU	Federal Bureau of Maritime Casualty Investigation, Hamburg, Germany
CPP	Controllable pitch propeller
DnV	Det Norske Veritas
ECDIS	Electronic nautical chart
ECR	Engine control room
Length o.a.	Length over all
ME	Main engine
MP	Measuring point
O.D. box	Oil distribution box (important control component of the controllable pitch propeller system)
port	Vessel side in ahead direction left
Stbd	Vessel side in ahead direction right
rpm	Revolution per minute
RR	Rolls-Royce AB, Kristinehamn, Sweden
WSP	Water Police for the Region of Lübeck-Travemünde

2. INVESTIGATIONS and RESULTS

2.1 Inspection on board MS FINNLADY on 2008-11-18

2.1.1 Meeting on board

This meeting was attended by:

[...]	Superintendent	Finnlines PLC, Finland
[...]	Captain MS FINNLADY	Finnlines PLC, Finland
[...]	Chief Engineer MS FINNLADY	Finnlines PLC, Finland
[...]	Control Systems Engineer	Rolls-Royce AB, Sweden
[...]	Technical Product Management Engineer	Rolls-Royce AB, Sweden
[...]	Investigator	BSU, Germany
[...]	Investigator	BSU, Germany
Mr Norbert G. Erles	appointed Technical Expert	on behalf of BSU, Germany

[The minutes of meeting are not included as an appendix.]

The Chief Engineer mentioned above, [...], was on board at the time of the accident (2008-05-16). During the meeting, the shipping company representative and the vessel command once again explained the course of the event on 2008-05-16, and the documents listed in Chapter 1.6.2 were handed over to all those attending the meeting.

In a subsequent discussion, questions relating to the contents of these documents were asked, in addition to detailed technical questions directed by BSU and the appointed expert in charge to the RR representatives.

[... *summary made anonymous by BSU:* It was mentioned that the same or similar fault and alarm signals had occurred frequently on the sister vessels. No more details were given during the meeting.]

[... It was] commented that the same fault had occurred once in the past on the sister vessel FINNMAID. The cause was determined as a "filthy" (dust contaminated) CAN bus housing and inadequate installation of the equipment in this housing.

The meeting described above was followed by an inspection of the bridge and its technical equipment, the engine control room (ECR) and its technical equipment, certain areas of the various engine rooms (main engine in general and oil distribution box of the port and starboard CPP system), the CPP hydraulic system, including the local emergency control system for the pitch adjustment of both propellers, and a store room accommodating one of the two CAN boxes.

2.1.2 Inspection of the bridge (Figures 1 - 8)

Inspection of the bridge focussed largely on the equipment, i.e. the relevant main propulsion monitoring panel. The bridge conning positions were activated for a simulation of the fault and alarm signals, for comparison with the fault and alarm signals on 2008-05-16. Then the fault signal "CPP STBD FAIL (Failure)" and the alarm signal "CPP SYSTEM WARNING (Alarm)" specified under Chapter 1.4 were simulated on both wing conning positions for both the port and the starboard propulsion system by issuing a manoeuvre command with the drive lever (7). As the CPP hydraulic pumps were not in operation, corresponding fault and alarm signals were generated from the main propeller control system. The simulation was carried out for the port and starboard propulsion systems individually.

The fault could be rectified in each case by pressing the "Re-connect" button. As long as the drive lever was not at 0 thrust during this simulation, i.e. in the neutral position, the fault and alarm signals could be reproduced repeatedly and reliably.

The time it takes for the system to detect faulty functioning (deviation from the manoeuvre command compared with the actual pitch/rpm ratio) depends on various software-programmed scan sequences and the specified time-related scan frequency. With a deviation of 1.5% from the target value characteristic, the hydraulic "control valve" opens to 75% and the fault scan sequence is started again. If, after scanning twice, a 0.75% deviation is determined, the fault and alarm signal is activated. From identification of a deviation until the fault and alarm signal is output takes a maximum of 9 seconds, as explained by RR. This was also confirmed during the course of various simulations.

In the original state, when the two MPs "CPP --- FAIL" and "CPP SYSTEM WARNING" were activated, an audible alarm (buzzer) sounded and a visual alarm was issued, within the relevant fields on the main propulsion monitoring panel flashing "System Warning" (an illuminated field for both CPP systems) and a "Control Failure" field, separately for the port and starboard systems, at all conning positions both on the bridge and in the engine control room. After 6 seconds, the audible alarm and the flashing were automatically reset, i.e. the buzzer stopped and the flashing light became a steady light.

During a system check carried out by RR after occurrence of the fault, the time until automatic resetting of such a fault and alarm signal was increased to 15 seconds upon the request of the vessel's command.

2.1.3 Inspection of the engine control room (Figures 9 - 12)

Inspection of the engine control room focussed largely on the main propulsion monitoring panel. After manoeuvre responsibility had been transferred from the bridge to the engine control room, the same simulation tests as on the bridge were carried out for both main propulsion systems. The results were identical to those of the simulations on the bridge. In addition, the issuing alarm signals were observed on the alarm monitor in the ECR.

A further test confirmed unequivocally that, when switching over manoeuvre responsibility from the bridge to the engine control room by actuating the selector switches (port and starboard side) in the engine control room (4), the manoeuvre responsibility is transferred immediately to the engine control room irrespective of whether or not the visual and audible alarms are cancelled on the bridge. Transferring manoeuvre responsibility while the fault and alarm signals were active meant that the system faults "CPP STBD / PORT FAIL" and "CPP SYSTEM WARNING" could be reset electronically as soon as the "Re-connect" button was pressed.

2.1.4 Inspection of certain areas of the engine rooms

In the engine room, the oil distribution box on the CPP system on the port and starboard side was subject to a basic visual inspection. No special findings or indications of repairs and/or modification measures were determined.

The CPP system's hydraulic power pack (Figures 13 - 15) was also subjected to a basic visual inspection. Here too, no special findings were determined. The instrument panel, the various controls and the switch devices for emergency operation of the propeller pitch adjustment function were in fault-free condition and clearly labelled.

2.1.5 Inspection of a store room in the passenger area

In a line store in the passenger area on Deck 9, one of the two CAN bus housings (Figure 16) was opened for inspection. The condition of the cabling and its feed-through into the housing, the way in which the cables had been connected and fixed, the strip terminals and a larger electronic module (CanMan gateway) on the mounting rails were found to be fault-free and OK. The various strip terminals and the associated cable clips were all fixed. There was no noticeable indication of thermal loading on any items of that equipment.

In view of the extremely good condition determined, a mutual agreement was reached that there was no need to carry out the same investigations on the other side of the vessel.

2.2 Evaluation of the available information

2.2.1 Classification - DnV

The layout and configuration of the equipment, among other things the main propeller control system of the main propulsion system, including the relevant peripherals, had been examined and approved by the relevant classification society Det Norske Veritas (DnV). The installation and testing of the relevant systems, components and equipment had also been surveyed and approved by the classification organisation DnV prior to the formal delivery of the vessel. At the time of the occurrence of the damage event, to the best knowledge of the appointed expert in charge, there was no class-related damage reported and no periodic inspections were due or overdue. The class status was confirmed without any restriction.

2.2.2 Design details – main propeller control system – RR

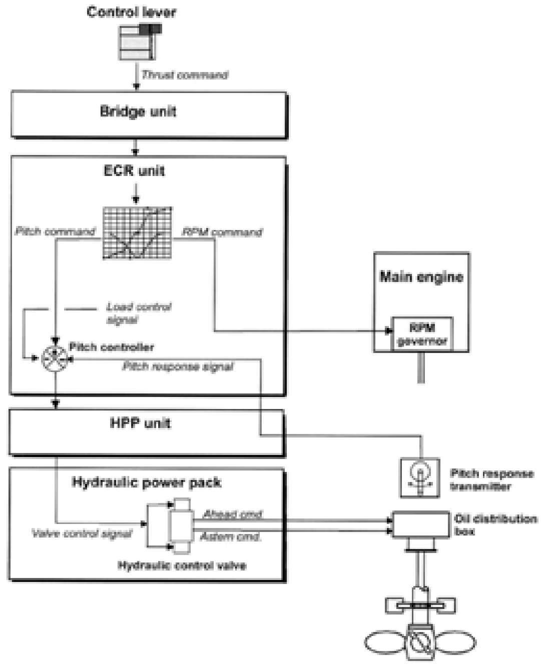
The main propeller control system is designed as a modular, microprocessor-based automatic control system, which goes some way beyond the function of a pure main propulsion remote control. The main propeller control system controls both the rpm of the main engines and the propeller pitch for the port and starboard main propulsion system, separately and depending on programmed characteristic curves. In automatic mode, a distinction can be made between two fundamentally different operating regimes: firstly combinator mode and, in contrast, operation of diesel engines with a constant rpm (constant speed mode) and therefore also a constant propeller shaft rpm reduced via reduction gears. The electronic signal is transmitted via a redundant CAN bus system.

In the modified version for vessels in this new model line, the main propeller control system includes a whole range of important control, protection and safety functions. These are generally the following basic functions:

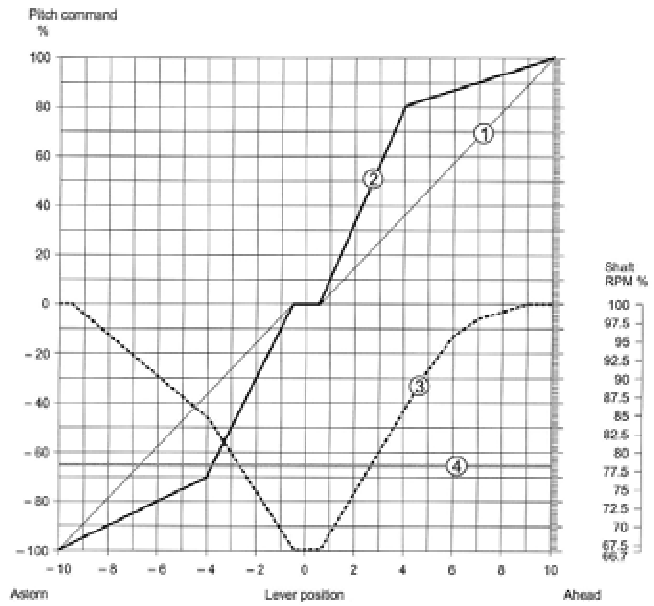
- Control of propeller pitch and engine rpm according to thrust commands given by the operator
- Manoeuvre responsibility management
- Automatic load regulation of the main engines
- A load increase control program for engine warming-up stages
- Two control modes: combinator mode and constant rpm mode
- Fault detection, status supervision and alarm activation
- Clutch control of the main engines
- Separate rpm control
- Load sharing between engines on the same shaft.

In order to realise these functions, largely standardised intelligent microprocessor units (control nodes or application nodes [CCN]) and non-intelligent data in/out units [SLIO]) in particular are used.

The entire main propeller control system is designed as redundant in the components important to operation and in the command transmission and response channels. Redundancy is achieved either through physical redundancy, i.e. identical modules, which are operated in "master/slave" mode, or through software-realised functional redundancy.



Schematic of the thrust control functions (SLIO units left out)
(Source: Rolls-Royce User's Manual, Document No. 51191 - E - Rev. B)



Example of a combinator diagram
(Source: Rolls-Royce User's Manual, Document No. 51191 - E - Rev. B)

Caption:

1 Pitch setting in constant rpm mode and when engine is disengaged
2 Pitch setting in combinator mode
3 Rpm setting in combinator mode
4 Rpm setting in constant rpm mode

2.2.3 Investigations after occurrence of the damage event - RR

In the period between 2008-05-25 and 2008-05-27, the CPP system equipment was checked by a RR engineer with the aim of finding and eliminating the cause of the fault and alarm signal that occurred on the starboard main propulsion system. During the thorough checks and testing carried out, no faults or malfunctions could be determined either in the electrical/electronic systems or in the hydraulic systems. No indications of a possible cause could therefore be postulated.

In order to optimise the overall operating behaviour of the main propeller control system, various system parameters were adjusted slightly (but not changed fundamentally). This provided an opportunity, upon the request of the vessel's command, to increase the active phase for the fault and alarm signals - MP "CPP --- FAIL" and "CPP SYSTEM WARNING" from 6 to 15 seconds. The vessel command had also questioned why, after this set time, the audible alarm (buzzer) automatically stops.

2.2.4 Administrative measures - Finnlines

By means of the circular letter, which was dated 2008-05-21 and addressed to the vessel commands of the sister vessels of identical design and other shipping company vessels with similar propulsion concepts, the vessel commands were informed in detail of the damage event on the FINNLADY and were requested to take appropriate operational precautions to effectively avoid any repetition of this damage event.

2.2.5 Proposals of the MS FINNLADY vessel command

As a result of the events of 2008-05-16, the vessel command of the FINNLADY made the following proposals:

- Extend the duration of the alarm to 15 seconds (realised)
- Improve visibility conditions in the area of the bridge panel
- Audible alarm should not be cancelled before the fault is rectified
- Increase volume of the audible alarm signal (buzzer)

3. SUMMARY

3.1 Can a systematic or system fault be determined?

Despite intensive endeavours on the part of the manufacturer of the main propeller control system, with the assistance of the technical department of the shipping company and the vessel command, the causes of the fault that occurred on the FINNLADY could not be determined. The evaluation of the logged fault signals throughout the entire available period during which such data were stored also gave no indications of possible or actual causes.

The identical fault that occurred on the sister vessel FINNMAID does not correspond to a systematic or system fault. Irrespective of the system, the causes lie in inadequate workmanship during the installation of the CAN bus housing and its internal wiring.

3.2 Operational behaviour during manoeuvring

At the time of the occurrence of the fault and alarm signal described several times in detail above, the Captain and Chief Officer were unaware of the consequences when manoeuvring the vessel.

The manoeuvring crew in the engine control room [...] either did not perceive the hazardous situation for the vessel, which must have been clearly noticeable, or ignored the possible consequences.

Only when, after some time, the "bridge" had detected the fault behaviour of the starboard CPP system and [...] had called [...] the engine control room, [they were...] advised [...] by phone to press the "Re-connect" button on the bridge console. At this point, no manoeuvre could have prevented the FINNLADY from colliding with pier 6.

A postulated lack of familiarity with the main propulsion system combined with the undoubtedly proven fact that, during the manoeuvre in question, the "bridge" and the "engine" did not interact as required ultimately triggered the damage event.

4. MEASURES – RECOMMENDATIONS

The realisation of the following measures is considered by the appointed expert in charge to be urgently required in order to reliably prevent such damage events in future on the FINNLADY and on its sister vessels of the same design.

4.1 Operational measures

1. The vessel commands and officers/engineers on the FINNLADY and the other sister vessels should be familiarised in detail by qualified personnel of the manufacturer or by specially trained personnel of the shipping company with all systems necessary for manoeuvring the vessel. This applies in particular to electronically resetting the system or switching to "Back-up" operating mode.

   The success of this training measure should be verified appropriately. After successful participation, participation certificates should be issued. Copies of these participation certificates should be held in the personnel file for the relevant crew member.

2. A refresher course, including a knowledge review for the specified personnel group, should be carried out at regular intervals in order to ensure that the knowledge has not been lost.

3. The shipping company's crewing management should ensure that only captains, chief engineers and other officers/engineers who fulfil these prerequisites are employed on board this vessel.

4. The description of the training procedure necessary for this should be documented in the ISM documentation and in quality management for the vessels and for the technical management at the shipping company, and implementation of these training measures should be made mandatory.

5. As standard procedure, it should be obligatory for the engineer responsible in the engine control room during the manoeuvring of the vessel to take immediate action and contact the "bridge" via telephone as soon as he/she determines that manoeuvre commands are not being correctly followed by the system for whatever reason.

   Direct intervention into functions of the main propeller control system, e.g. switching manoeuvre responsibility from the "bridge" to the engine control room, must be coordinated in advance with the bridge officer on duty and in general with the Captain.

6. In the case of estuary trading, a suitable sunshield on the bridge windows should be used to ensure that, even when the sun is low, glare does not detract from the perceptibility of the fault and alarm signals. (Suitable roller sun blinds are fitted at the individual bridge windows).

4.2 Program modifications

1. Modification of the software so that, in the event of such fault and alarm signals occurring, the activation status, i.e. flashing light and acoustic alarm, is maintained until the fault and alarm signal is reset electronically through appropriate measures, e.g. by pressing the "Re-connect" button.

2. The visual perceptibility of fault and alarm signals of the main propulsion monitoring panel should be improved.

3. The acoustic perceptibility of fault and alarm signals of the main propulsion monitoring panel should be strengthened. This can be achieved by either increasing the volume or changing the signal frequency.

4.3 Additional proposed measures

1. As a preventative measure, taking into consideration the findings to date, a check of the main propeller control system should be carried out on the sister vessels.

2. Because electronic system components involved in signal processing and signal forwarding, e.g. semiconductor elements, may "drift" after a while, i.e. change their characteristic values, the parameterisation data / calibration data of these components should be checked, and if necessary, adjusted at specific intervals in coordination with the system manufacturer.

Flensburg, 2008-12-18

Norbert G. E r l e s

A P P E N D I X

- Expert Opinion -

Establishment of the technical causes of the fault within the starboard propulsion system of the RoPax-ferry FINNLADY and the subsequent collision with docking pier 6 at Travemünde ferry port

Expert Opinion No. 02-2008 Er Version A

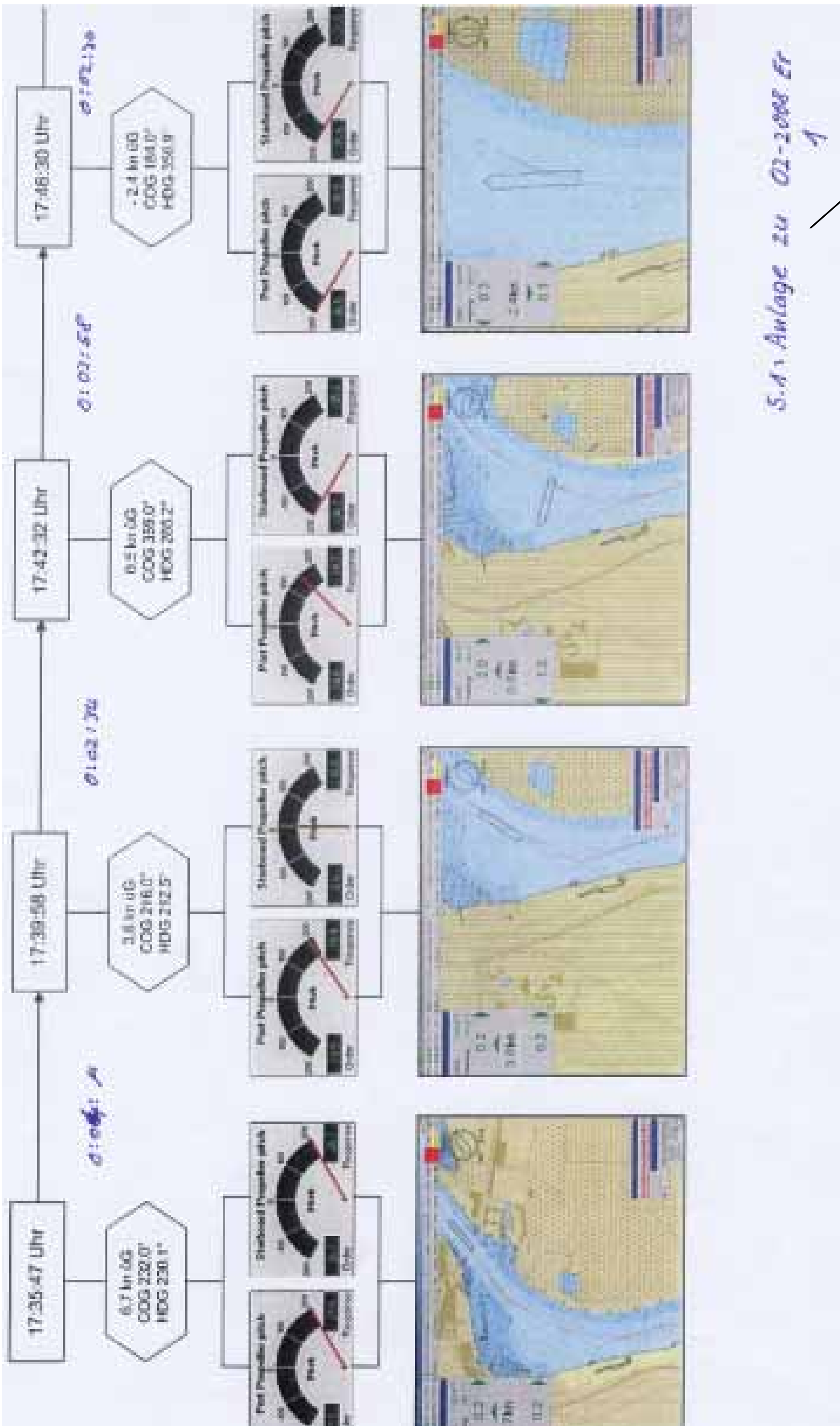
The appendix comprises 20 pages
including this cover sheet

Flensburg

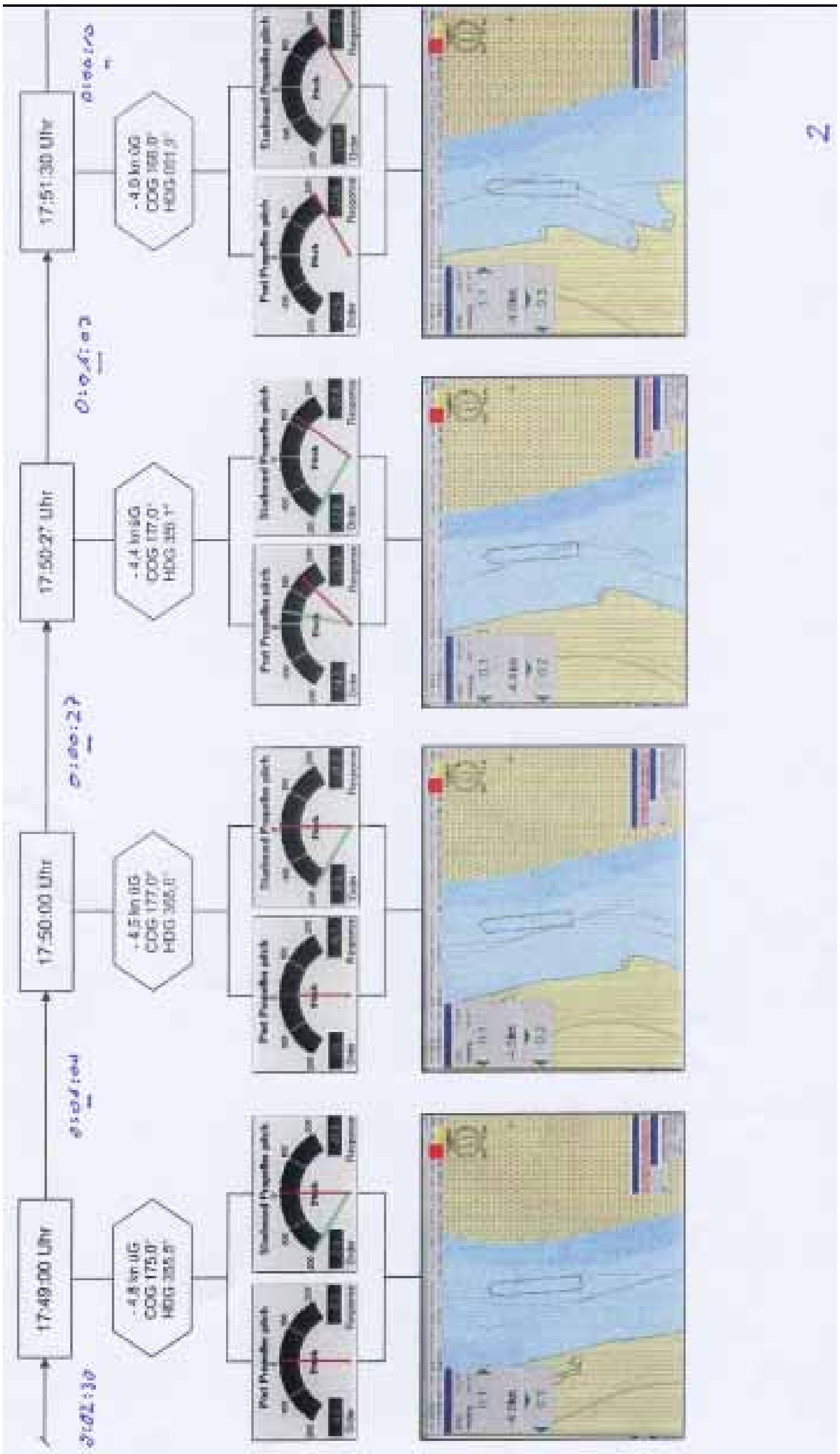
2008-12-18

5. A P P E N D I X

5.1 Extracts from the electronic nautical chart (ECDIS) - 2008-05-16 (UTC)



5.1 Appendix to 02-2008 - Er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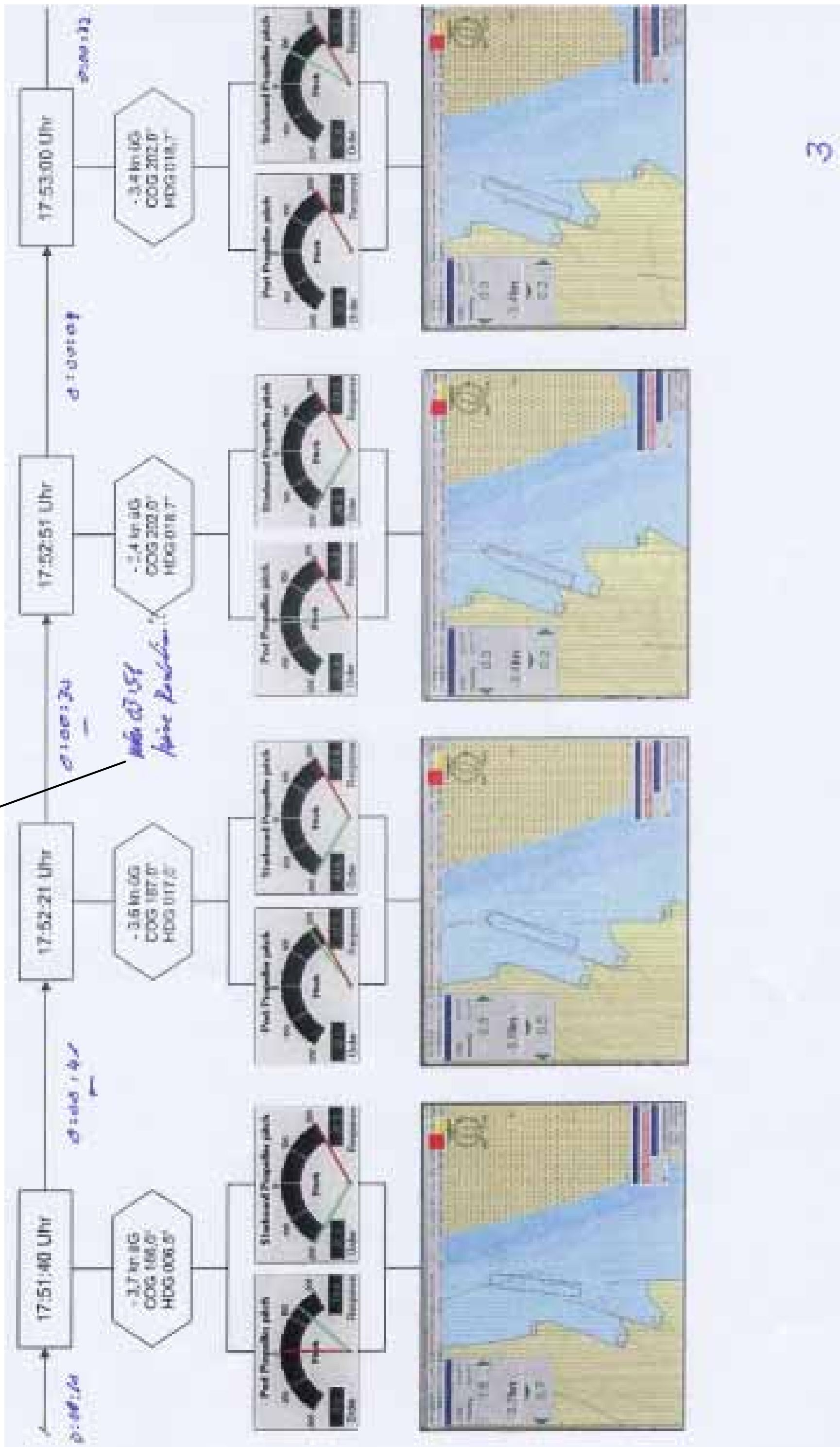
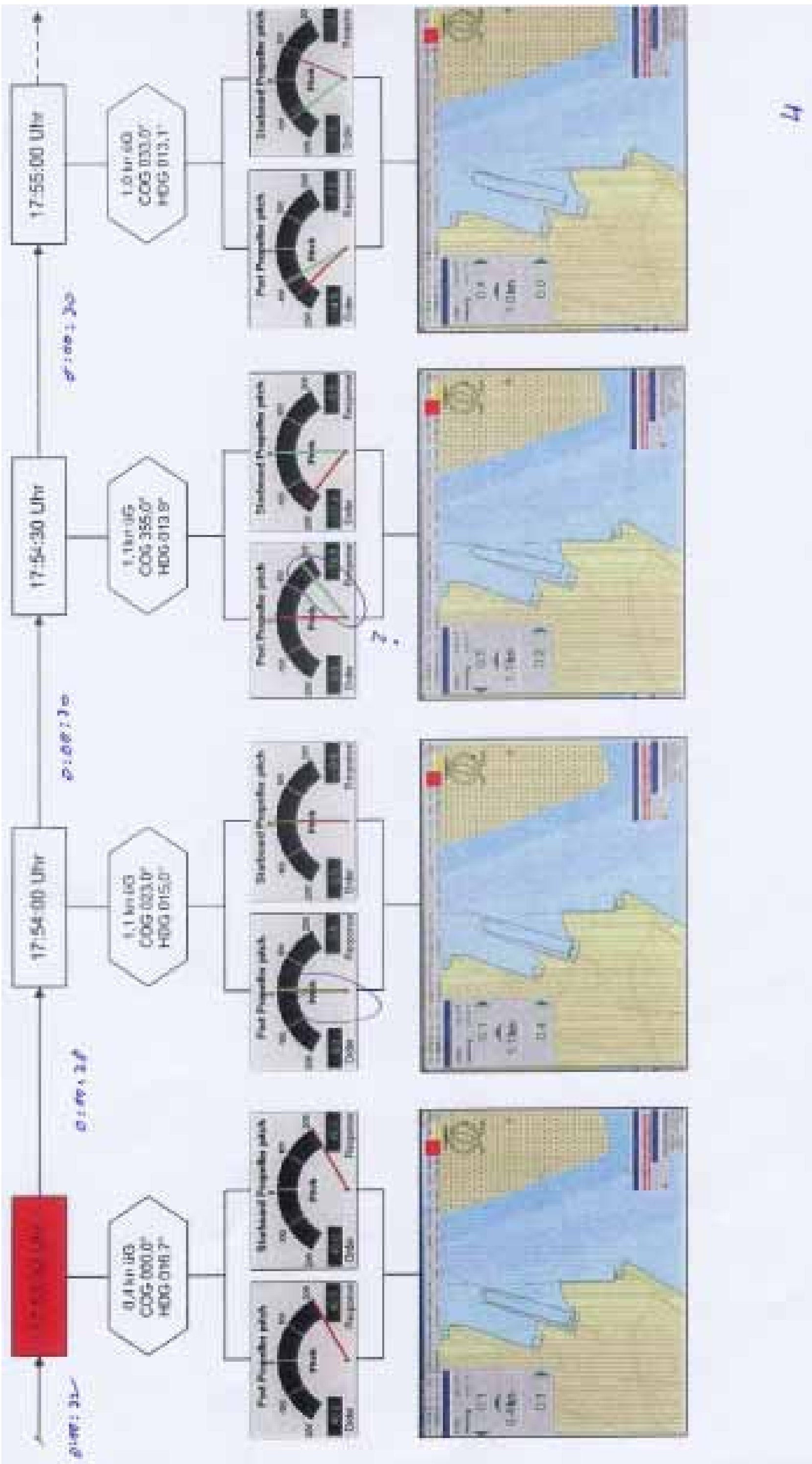
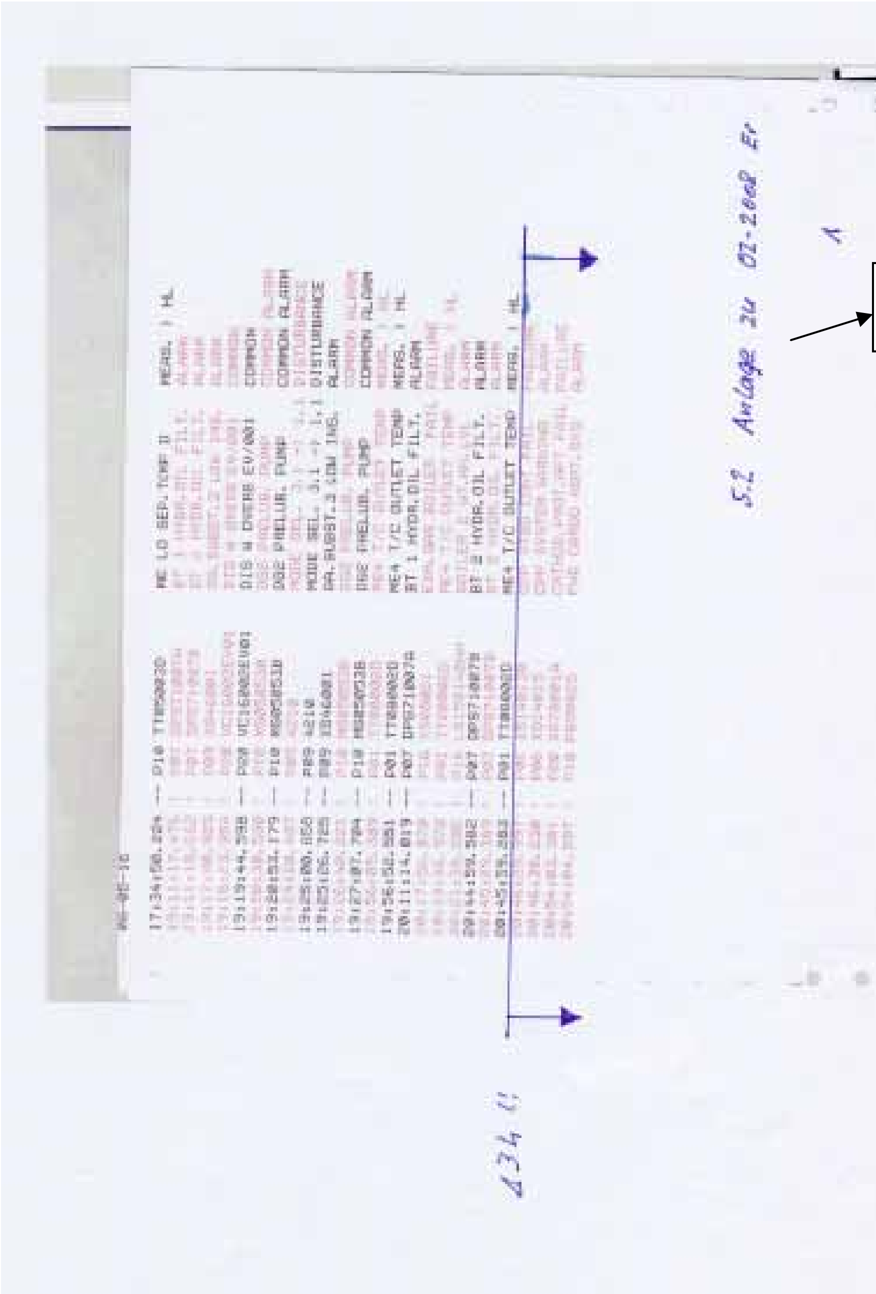
17:50:00 Uhr
17:51:30 Uhr

Duration of wrong pitch setting of STBD-propeller: minimum 03‘ 51“

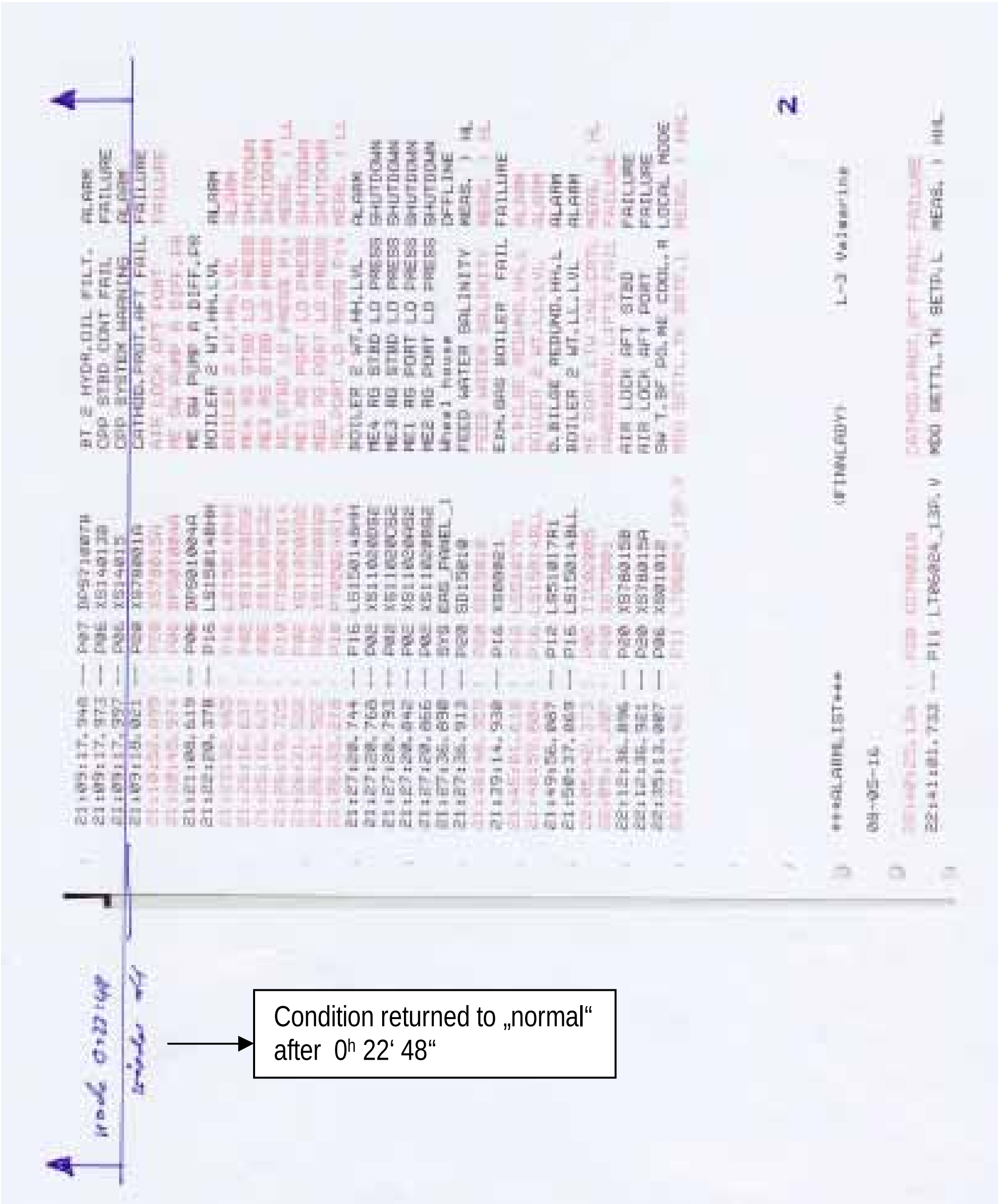



17:55:00 Uhr
17:54:30 Uhr
17:54:00 Uhr

5.2 Extracts from the alarm list - 2008-05-16



5.2 Appendix to 02-2008 - Er


Condition returned to „normal“ after 0h 22‘ 48“

5.3 Photo documentation

Figures No.	Description	Pages
1	Bridge wing conning station - overview	5, 10
2	Bridge wing conning station - main propulsion monitoring panel including drive lever	5, 10
3	Bridge wing conning station - main propulsion monitoring panel	5, 10
4	Bridge wing conning station - emergency panel ME 1 and Me 2	5, 10
5	Bridge wing conning station - „Back-up“ panel	5, 10
6	Bridge wing conning station - load control buttons and indication lamps	5, 10
7	Central bridge conning station - overview	5, 10
8	Central bridge conning station - details	5, 10
9	Main propulsion console (overview) - ECR	5, 10
10	Main propulsion monitoring panel (overview) - ECR	5, 10
11	Main propulsion monitoring panel (details) - ECR	5, 10
12	Alarm monitoring console - ECR	5, 10
13	CPP hydraulic-power-pack with emergency operating devices	11
14	Emergency operating devices - solenoid valves	11
15	„Change-over“ main propeller control system operating mode - emergency operation mode	11
16	CAN-BUS housing (opened-up)	11

Bridge wing conning stations

Fig. 1: Bridge wing conning station - overview

Fig. 2: Bridge wing conning station - main propulsion monitoring panel including drive lever

Fig. 3: Bridge wing conning station - main propulsion monitoring panel

Fig. 4: Bridge wing conning station - emergency panel ME 1 and ME 2

Fig. 5: Bridge wing conning station -
„Back-up“ panel

Fig. 6: Bridge wing conning station -
load control buttons and indication lamps

Central bridge conning station

Fig. 7: Central bridge conning station - overview

Fig. 8: Central bridge conning station - details

ECR installations

Fig. 9: Main propulsion console (overview) - ECR

Fig. 10: Main propulsion monitoring panel (overview) - ECR

Fig. 11: Main propulsion monitoring panel (details) - ECR

Fig. 12: Alarm monitoring console - ECR

CPP hydraulic-power pack

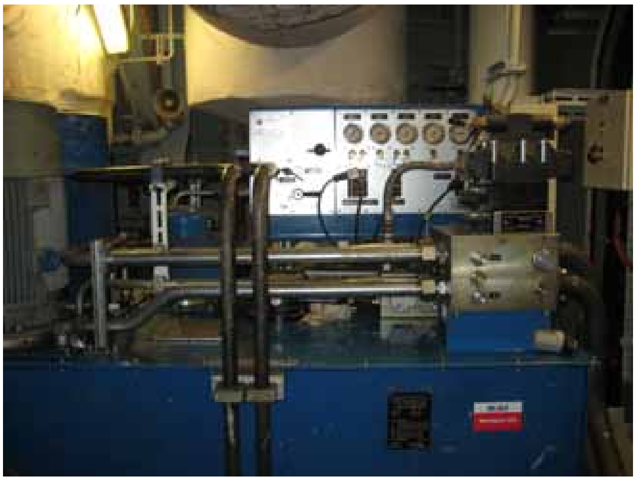


Fig. 13: CPP hydraulic-power pack with emergency operating devices

Fig. 14: Emergency operating devices - solenoid valves

Fig. 15: „Change-over“ main propeller control system operating mode - emergency operation mode

CAN-BUS housing

Fig. 16: CAN-BUS housing (opened-up)

5.4 Record of the on-board inspection on 2008-11-18

[not attached]