APPENDICES

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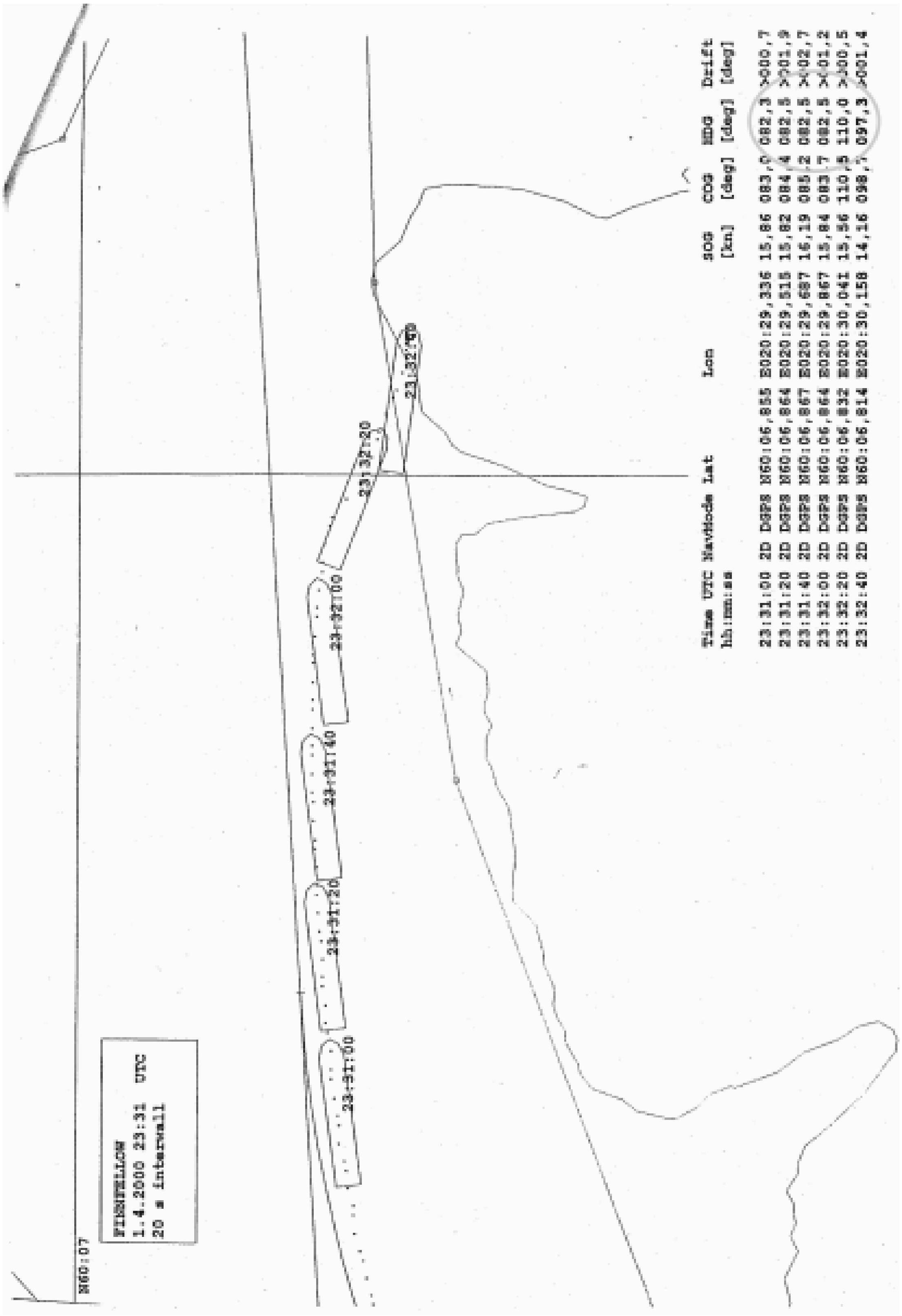
APPENDIX 1


FINNFELLOW
1.4.2000 23:31 UTC
20 s interwall
N60:07
23:31:00
23:31:20
23:31:40
23:32:00
23:32:20
23:32:40
Time UTC NavMode Lat Lon SOG COG HDG Drift
hh:mm:ss [kn] [deg] [deg] [deg]
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23:31:20 2D DGPS N60:06,864 E020:29,515 15,82 084,4 082,5 001,9
23:31:40 2D DGPS N60:06,867 E020:29,687 16,19 085,2 082,5 002,7
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23:32:20 2D DGPS N60:06,832 E020:30,041 15,56 110,5 110,0 000,5
23:32:40 2D DGPS N60:06,814 E020:30,158 14,16 098, 097,3 001,4

APPENDIX 2

Simulco Oy

REPORT R2604001

RECONSTRUCTION OF MOTION TRACK OF M/S FINNFELLOW BEFORE GROUNDING ON APRIL 2, 2000

Simulco Oy has been commissioned by the Accident Investigation Board to study and reconstruct the probable track of M/S FINNFELLOW during the two minutes before she grounded on April 2, 2000.

Simulco's simulation software for steering of a ship was used for the study. The hydro- and aerodynamic properties of a vessel the type of the FINNFELLOW have been modelled in the software.

The calculations are based on the data registered by the ANS Blackbox application on board the ship. The registered information includes ships position, heading and speed and course over ground. The following information received from the shipping company of the FINNFELLOW has been used as starting values for the study:

- The ANS Blackbox registration application was configured to collect information from the Ship's Interface of the NACOS navigation system by Atlas Elektronik at the time of the incident.
- The position of the vessel was measured by a DGPS receiver. Its antenna is located 5 meters aft of midship and half a meter port of the keel line. The DGPS-receivers position data was calculated to correspond to the location of the reference point in the navigation system before sending the information through the Ship's Interface. The navigation system uses the heading information given by the gyro-compass for this calculation. The reference point is located on the keel line of the vessel 41.5 meters fore of midship. No other conversions are assumed in the position calculations by the DGPS. Therefore, the position information received and registered by the ANS Blackbox application corresponds to the geographical location of the reference point except in a situation where the heading information given by the gyro-compass was false.
- The heading measured by the gyro-compass was recorded as such.
- Course over ground was calculated in the navigation system with the help of the course information from the receiver and the heading from the gyro-compass.

  As in the above, course over ground corresponds to the geographical location of the reference point except in a situation where the heading information given by the gyro-compass was false.
- Speed over ground was calculated in the navigation system directly from the longitudinal and lateral speed components measured by the log-sensor. The measured values were not changed, since the sensor is located at the reference point.

The track of the midship was calculated on the basis of the information recorded by the ANS Blackbox application (page 4) and with the help of the track, the course and speed over ground of the midship (pages 5 and 6).

The heading during the compass malfunction was estimated with simulations. The following starting values were used in the calculations: depth of water was set at an even 50 meters, wind heading at 350 degrees and wind speed at 9 m/s (Wind speed measured by the Finnish Meteorological Institute at Kumlinge weather station at 00:00 on April 2, 2000). The throttle settings for the main engines were kept constant during the simulations. Bank effects of the islands were not considered since they were irrelevant to the case at hand.

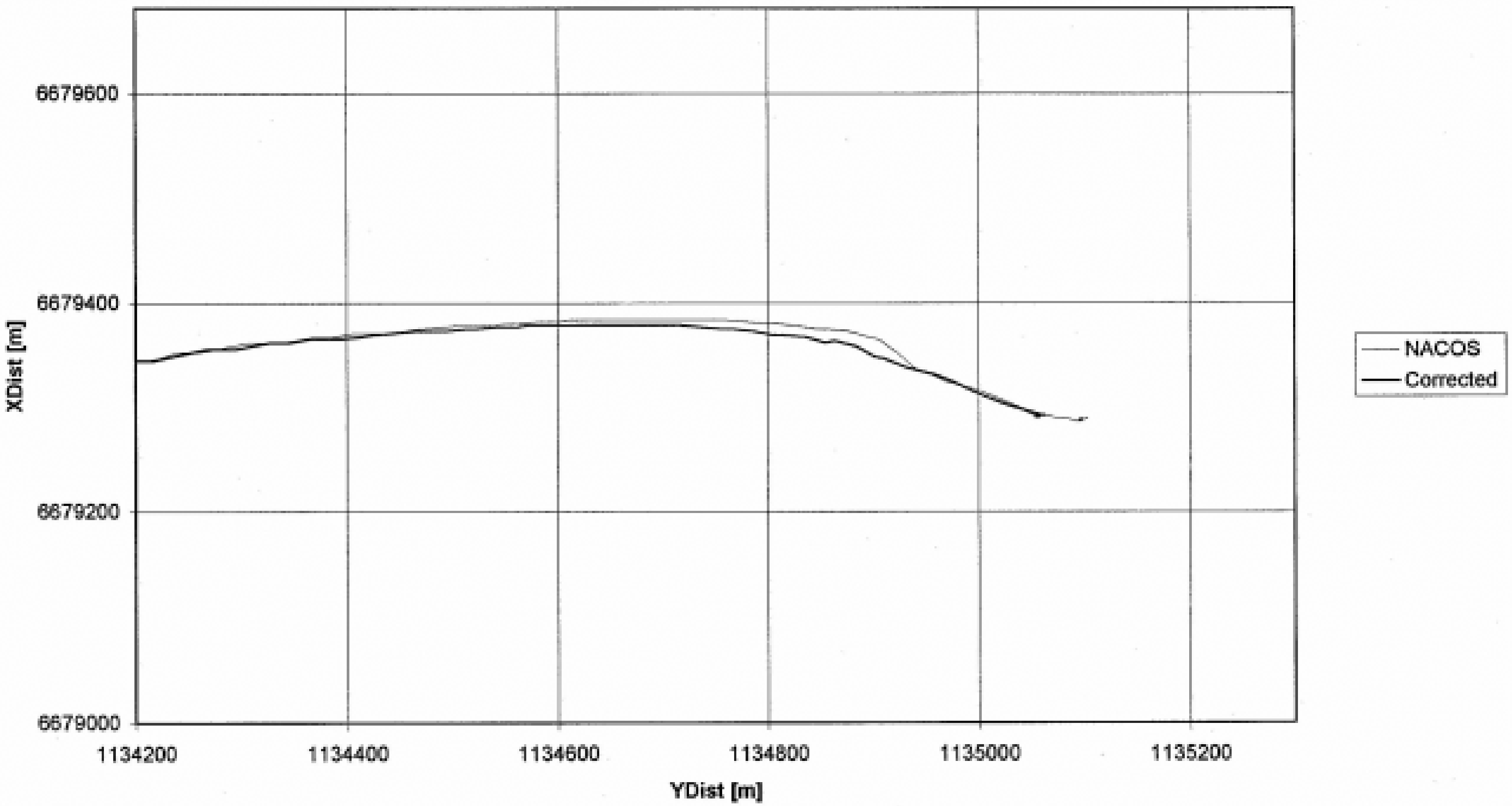
The estimated probable heading of the vessel during the compass malfunction is presented on page 5. The estimation is based on multiple simulations.

The corrected track is presented on page 7 together with the original recording by the ANS Blackbox application. In addition, a SimBox-compatible recording database was created of the calculated data making it possible to revaluate the accident situation in the ship handling simulator.

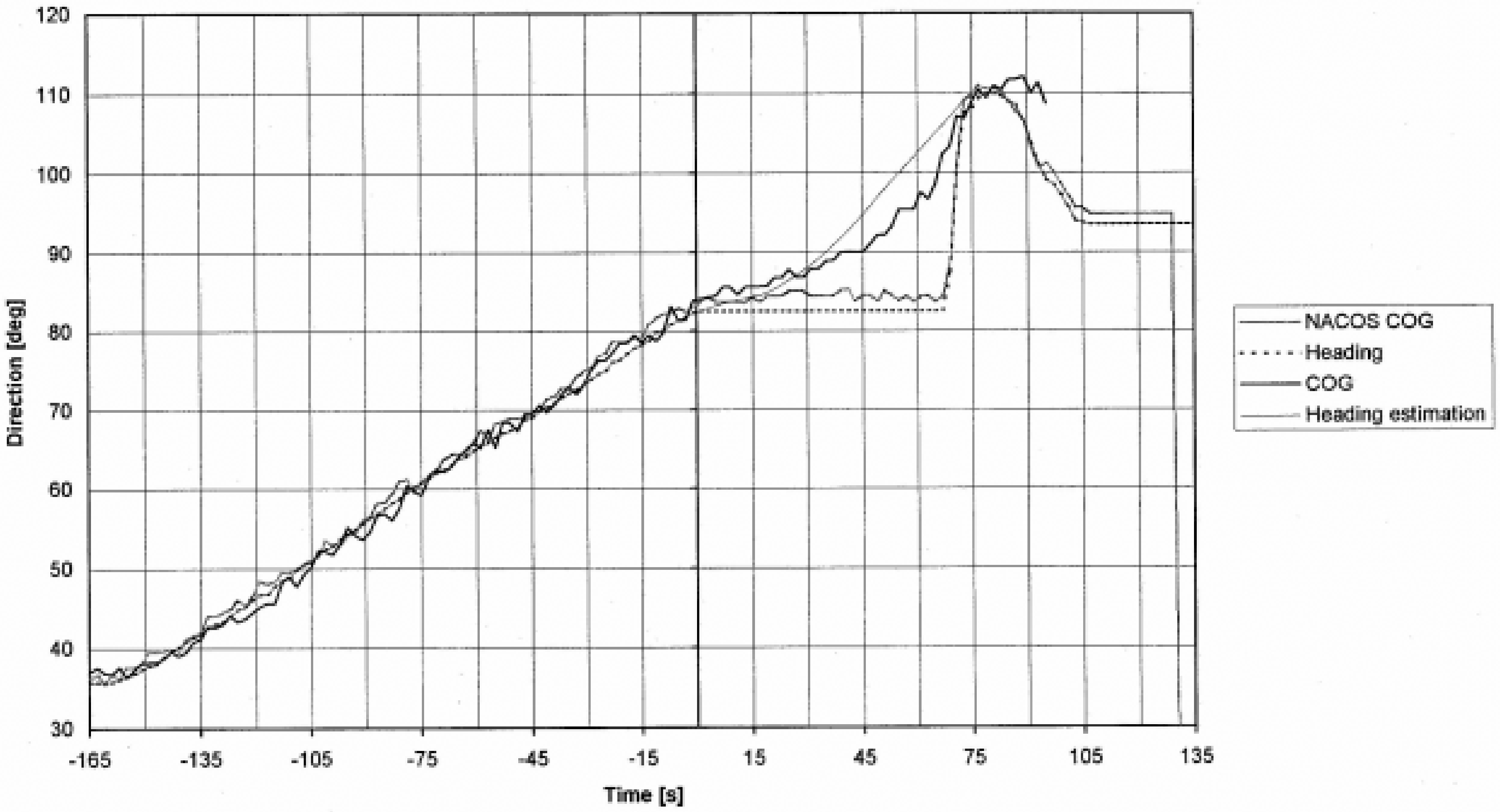
Espoo, April 26, 2000

SIMULCO OY
Jaakko Lehtosalo

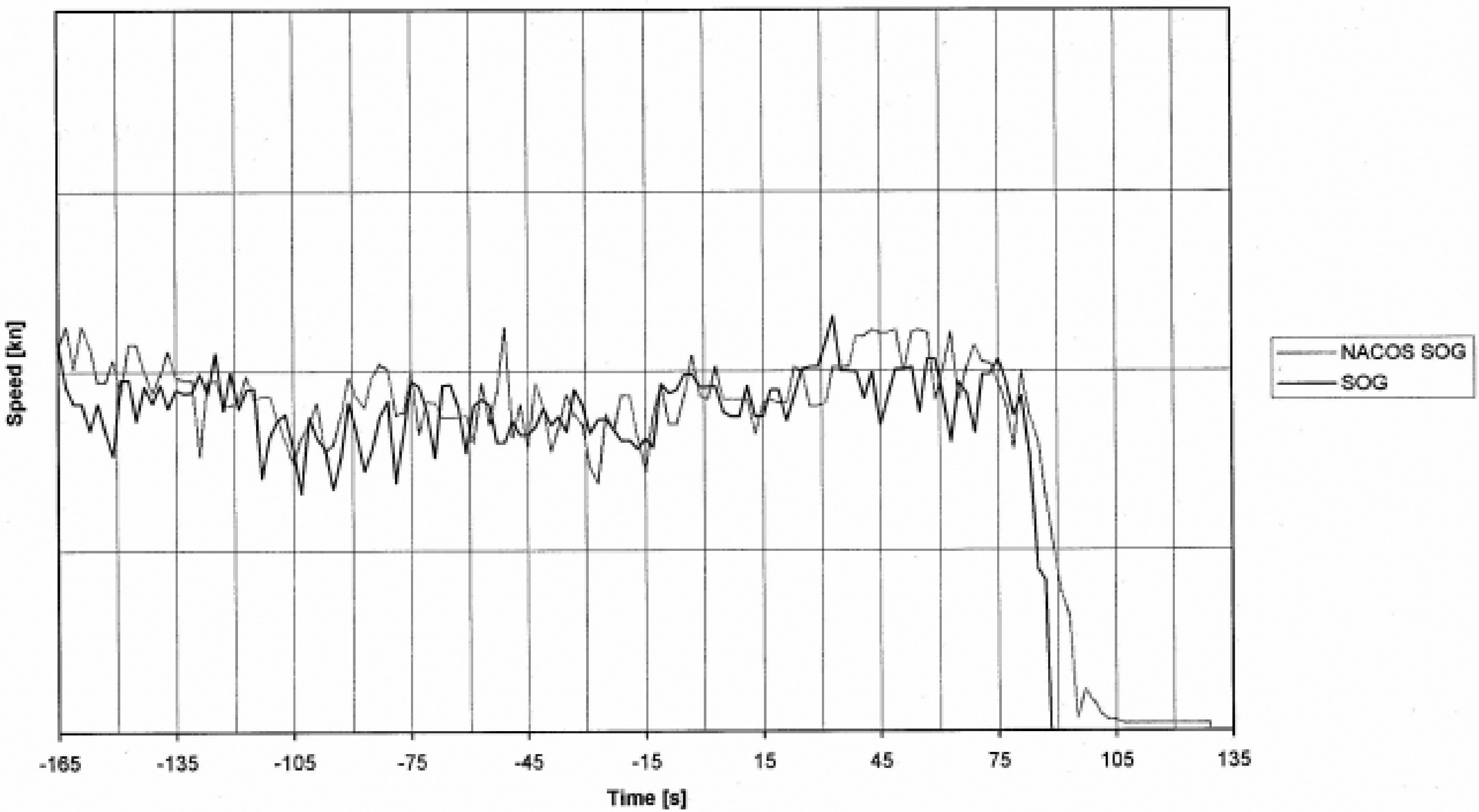
Position


6679600
6679400
6679200
6679000
XDist [m]
1134200
1134400
1134600
1134800
1135000
1135200
YDist [m]
NACOS
Corrected

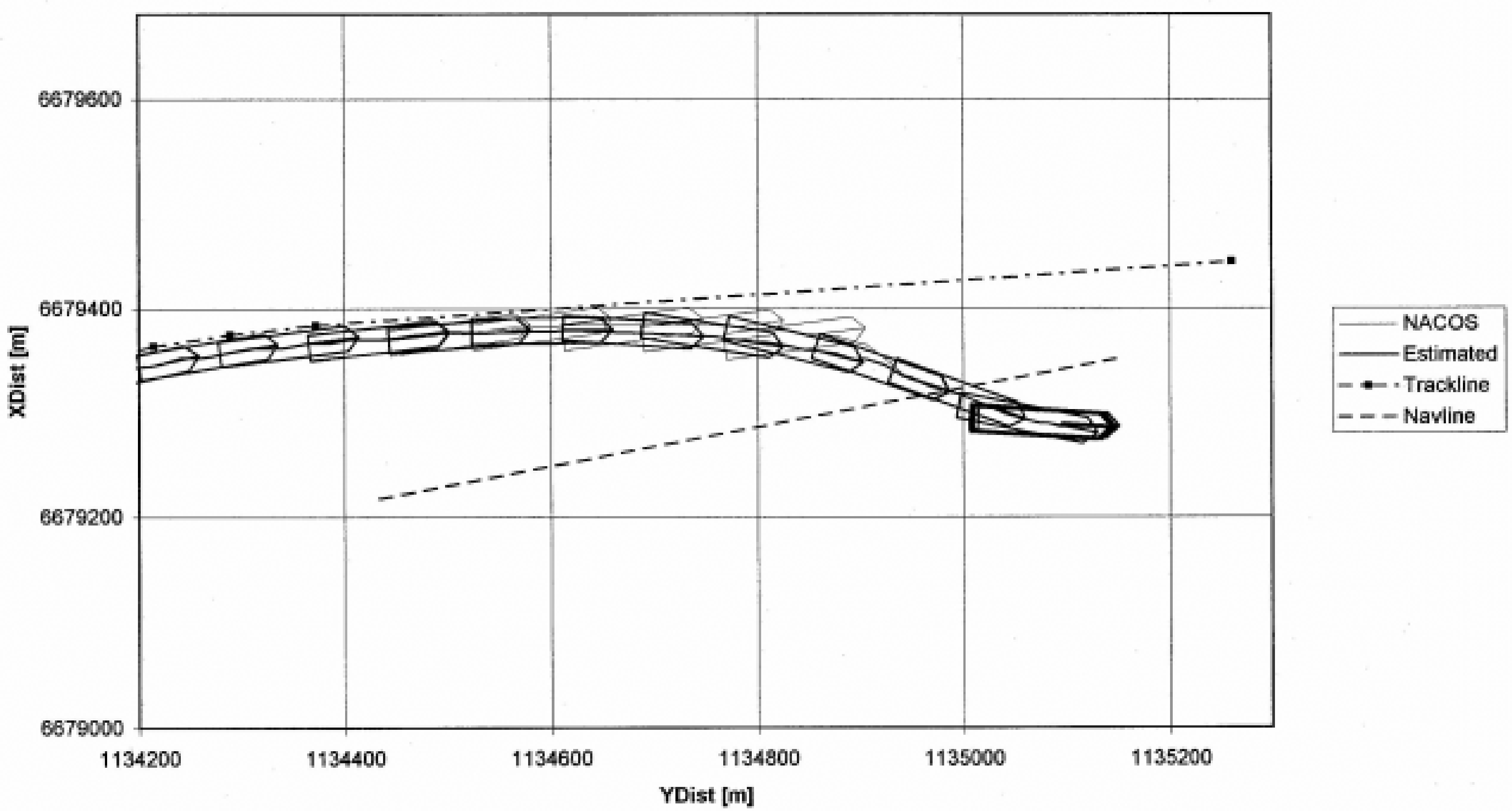
Heading and COG



Speed Over Ground



Track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6679400
6679200
6679000
XDist [m]
1134200
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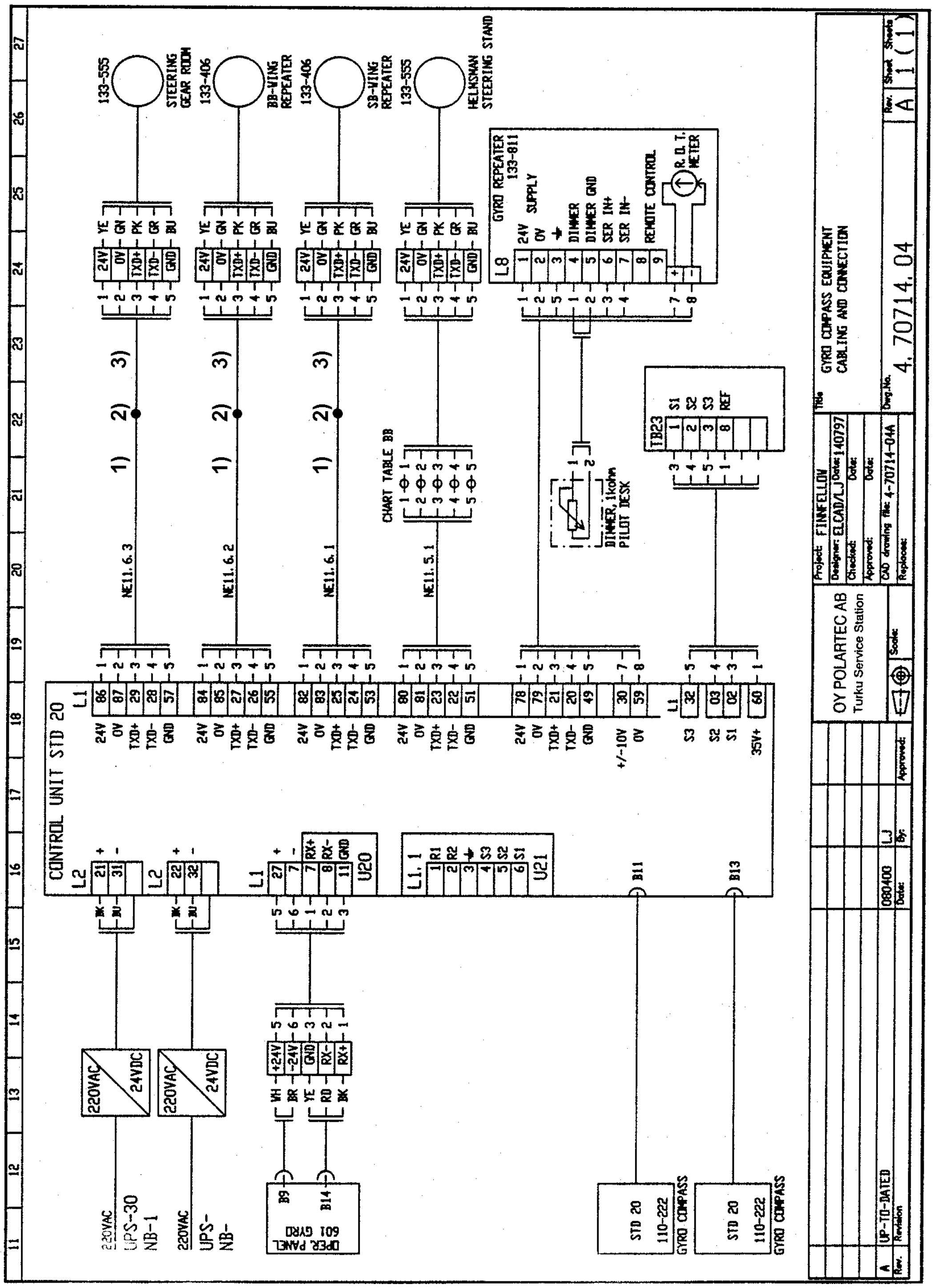
1134600
1134800
1135000
1135200
YDist [m]
NACOS
Estimated
Trackline
Navline



1) Häiriösuojattu kaapeli
2) Liitos
3) Häiriösuojaamaton kaapeli

1) Cable with disturbance protection
2) Joint
3) Cable without disturbance protection

Code of Error	Type of Error	Possible Cause	Measure
E 1	1 Operating voltages in compass faulty	1.1 Sensor electronics defective	1.1.1 Exchange sensor electronics (see Section 2.3.5.1)
E 2	2 Gyro supply faulty	2.1 Sensor electronics defective	2.1.1 Exchange sensor electronics (see Section 2.3.5.1)
E 3	3 Encoder faulty	3.1 Cabling out of order	3.1.1 Check cabling (see Section 2.3.4)
		3.2 Sensor electronics defective	3.2.1 Exchange sensor electronics (see Section 2.3.5.1)
		3.3 Encoder defective	3.3.1 Call Raytheon Anschütz Service
E 4	4 Gyro current faulty	4.1 Cabling out of order	4.1.1 Check cabling (see Section 2.3.4)
		4.2 Sensor electronics defective	4.2.1 Exchange sensor electronics (see Section 2.3.5.1)
		4.3 Gyrosphere defective	4.3.1 Exchange gyrosphere (see Section 2.3.5.2)
E 5	5 Follow–up faulty	5.1 Cabling out of order	5.1.1 Check cabling (see Section 2.3.4)
		5.2 Toothed belt jumped off	5.2.1 Put on the toothed belt again
		5.3 Sensor electronics defective	5.3.1 Exchange sensor electronics (see Section 2.3.4.1)
		5.4 Step motor defective	5.4.1 Call Raytheon Anschütz Service
		5.5 Gearing out of adjustment	5.5.1 Call Raytheon Anschütz Service
E 6	6 Temperature sensor breakdown	6.1 Cabling out of order	6.1.1 Check cabling (see Section 2.3.4)
		6.2 Temperature sensor defective	6.2.1 Exchange temperature sensor (see Section 2.3.5.3)
		6.3 Sensor electronics defective	6.3.1 Exchange sensor electronics (see Section 2.3.5.1)
E 7 *)	7 Height of gyrosphere out of tolerance	7.1 Sensor electronics defective	7.1.1 Exchange sensor electronics (see Section 2.3.5.1)
		7.2 Gyrosphere defective	7.2.1 Exchange gyrosphere (see Section 2.3.5.2)
		7.3 Pump defective	7.3.1 Call Raytheon Anschütz Service
E 8	8 Breakdown in heating	8.1 Cabling out of order	8.1.1 Check cabling (see Section 2.3.4)
		8.2 Heating cartridge defective	8.2.1 Exchange heating cartridge (see Section 2.3.5.4)
		8.3 Temperature fuse defective	8.3.1 Exchange temperature fuse (see Section 2.3.5.4)
		8.4 Sensor electronics defective	8.4.1 Exchange sensor electronics (see Section 2.3.5.1)
E 9 *)	9 Overtemperature > 70 °C	9.1 Cabling out of order	9.1.1 Check cabling (see Section 2.3.4)
		9.2 Ambient temperature too high (> 55 °C)	9.2.1 Switch on air conditioning
		9.3 Sensor electronics defective	9.3.1 Exchange sensor electronics (see Section 2.3.5.1)
		9.4 Temperature sensor defective	9.4.1 Exchange temperature sensor (see Section 2.3.5.3)

*) No longer valid from software version P02 E02.02

Appendix 5 Interpretation of FMEA analysis on Standard 20 compass

FMEA[1] (Failure Mode and Effect Analysis) is an analysis aimed at studying the operation of equipment in a fault situation. It can also be used for testing software and searching for possible sources of human errors. The FMEA analysis is not compulsory.

Raytheon has performed the FMEA analysis on the Standard 20 gyro compass in 1998[2]. This appendix presents a summary of the analysis. *The observations of the investigators concerning the point in question are given in italics.*

With regard to the gyro compass, the results of the FMEA comprised in the first group five columns. Here is an example of columns 1-5:

No.	Item/Identification	Function	Failure Mode and Courses	Type
1 - 1	Gyro Compass Equipment STANDARD 20	Gyro Compass	Compass internal operating voltages faulty	I

I = Internal problem of subsystem or sensor, E = Electrical

Columns 2 and 3 remain the same for the compass. The **Failure mode** column presents the faults each on its own line. The **Type** column indicates the fault type with one letter. In eight cases concerning the compass, the fault type is 'Internal Problem' (I) and in two cases an electrical fault 'Electrical' (E).

The second group defined the effects of the fault situations above in three columns. An example of this is given below. When the compass does not give heading information, the FMEA handles the situation as follows in columns 6 - 8:

Failure effects		
Local effects	**Next Higher Effects**	**End Effects**
Respective gyro compass supplies no heading values. Heading information on course bus invalid.	Invalid heading is distributed by course bus.	

- **Local effects** columns have the same text in nine fault situations where the compass does not give heading information. In one situation, it is stated that the heading information is wrong.
- **Next Higher Effects** columns have the same text of the invalid heading information not being distributed to the auxiliaries.
- **End Effects** columns have been left blank. *The effects of the fault on the entire navigation system or on the safety of the ship are left unaddressed.*

[1] FMEA IEC 1985
[2] FMEA, Raytheon Marine GmbH, 1998.

The third group, columns 9 - 12 dealt with alarms and corrective actions.

Failure Detection Method	Compensating Provisions	Repair Method	Remarks
STD 20 operation unit display: OPERATING VOLT GYRO SUPPLY ENCODER GYRO CURRENT FOLLOW-UP TEMP.SENSOR HEIGHT GYROSP **HEATING** OVERTEMP >70° GYRO ERROR'	Switch to second gyro compass or switch to TMC	R: 10 fault situations S: 9 fault situations C: 2 fault situations	

TMC = Transmitting Magnetic Compass
R = restart system, S = repair by spare, C = repair connection.

- **Failure detection method** column describes the alarm message appearing on the control unit. False heading information usually causes a total of ten different alarms, the HEATING alarm being one of them. *The alarm message bears no indication of the action recommendation. They represent maintenance situations.*
- **Compensating Provisions** column carries the same text on each line. *The user does not get the information that the system should be switched over to the other compass.*
- **Repair Method** column recommended in all instances rebooting the system and replacing the spare part. In one case, an additional recommendation of checking the connection was also given. *These are instructions for maintenance. The problem has not been considered from the point of view of the use of the compass, namely the navigation situation.*
- **Remarks** column was blank on each line. *The conclusion of the user not being able to act correctly based on confusing and cryptic alarm messages could have been drawn here, but the FMEA was limited to the operation of the gyro and not the effects of it.*

With regard to the Control Unit of the compass system, the FMEA presented four fault situations where false heading information is sent to the auxiliaries. One of the alarms 'NO CONNECTION', 'NO TELEGRAMS' and 'CU EXT.PCB.ERR' appears on the control panel. In these cases the compass must be switched over to emergency mode[3]. The alarm 'DISTRIBUT.ERR' requires reading the heading from the magnetic compass.

Summary. *It is not clear from the FMEA analyses, whether there is a sound for the alarms. The analysis gives the impression that the alarms are merely information and that the user may interpret their meaning himself. Fourteen serious alarms of the compass system remain without action recommendation or sound alarm.*

FMEA, as its name suggests, is an analysis, but the conclusions based on the analysis are missing. The conclusion that in each of the fourteen fault situations the alarm message 'SWITCH GYRO' and an audio alarm should be given can be drawn from the FMEA analysis. The current alarm messages do not support the decision making of the users. The analysis does not protect the overall outcome of the navigation and the vessel from accidents.

[3] The investigators could not find instructions for emergency use in the manual.

Appendix 6 Autopilot and integrated navigation

The development of large ro-ro passenger ferries and cargo ferries has led to the development of the integrated navigation systems and autopilots used in piloting. The use of an integrated navigation system arises from the needs for precise navigation and steering of vessels of the present size on narrow passages in the archipelago. At the same time, the steering practice in piloting has changed. The autopilot has substituted the helmsman. This transition has taken twenty years.

The technical recommendations on autopilots were issued in 1975 and 1996[4] but they do not take a stand on the use of the autopilot on the fairway or in piloting. Since the users of the equipment have not received support for their decisions from the regulations, the opinions about using the autopilot for steering on the fairways have split into for and against. Integrated navigation has changed the practices in piloting so that the use of autopilot in piloting is generally regarded acceptable.

The formation of a new practice has been slowed down by both juridical and technically outdated views of the use of electronic navigation equipment as navigational aids. The definition as “aid of navigation” includes the notion that the lawmaker does not take any responsibility of these.

The purpose of integrated navigation is to create a technical system which is not an aid but a system that can be relied on. The manufacturer of the integrated navigation equipment should provide clear requirements for the use of the equipment[5].

In maritime navigation, positioning and steering have traditionally been different tasks. They were separated earlier both technically and hierarchically. The division of work was also social. The integrated navigation system has changed navigation towards its original purpose by combining steering and positioning on the same screen. The system integrates positioning, steering and monitoring. Integrated navigation is not possible without planning of the passage, so it also promotes the realisation of the requirements of passage planning. Integrated navigation gives the greatest benefit for piloting.

The most central element in the integrated navigation system is the autopilot where combining information is transformed into executing the passage plan. The autopilot usually contains several steering modes. Manual steering is one of these, but its use means that either the pilot, the mate or the master is steering, because the effect of the steering commands related to the positioning must be derived from the radar screen. The helmsman cannot be employed for the steering since this would disintegrate the positioning and steering. The navigator makes the decisions, gives the steering commands to the autopilot or steers himself. Switching from the autopilot over to manual control must be easy. The officers of the FINNFELLOW acted according to the principles of integrated navigation.

[4] Recommendation on Performance Standards for Automatic pilots. A342(IX) 1975 and
Recommendation on Performance Standards for Heading Control systems. MSC.64(67) 1996.

[5] For example, the manuals of STN ATLAS ELEKTRONIK contain the requirements of the equipment manufacturer on the first page ’General Safety Precautions when using NACOS’, which give the operator clear requirements for the use.

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ACCIDENT INVESTIGATION BOARD
Attn.: Mr. Martti Heikkilä
Yronkatu 36

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FINLAND

MS FINNFELLOW GROUNDING IN ÅLAND ON APRIL 2, 2000
FINAL DRAFT OF INVESTIGATION BOARD REPORT

Dear Sirs,
we have studied the report of the investigation board with great interest. As the background of the accident seems to be quite complicated, we would like to comment the preliminary report as below. We would kindly ask you to consider to implement our conclusions and statements as far as you can agree.

We would like to begin with our two leading conclusions, how the accident could have been avoided:

a) HEADING MONITORING
There was **no heading monitoring** alarm installed on the vessel. This function, which compares the heading input to the autopilot with an independent heading source, is a basic requirement from IMO. The FINNFELLOW has not been equipped according to the IMO resolution. By this offense to the regulations, the single fault in the gyro system could not be detected, which led to the heading deviation and finally to the accident.

b) INSTALLATION VS. INSTALLATION DRAWINGS
The installation on board of FINFELLOW showed a major discrepancy in relation to the installation drawings, which have been prepared by the company POLARTEC.
The gyrosystem has not been connected by course bus, as shown in the wiring diagrams, but by step signal only.
This change has not been recorded anywhere.
With an installation like on the installation drawing, the single fault in the gyro system would have been detected and the accident would not have happened at all.

These two issues are root causes for the accident and should be considered as these.
In the following pages Raytheon Marine GmbH provides more detailed comments to the draft of the investigation report for your consideration.

1 General Comments on specific parts of the report

(We have referenced the comment by the paragraph no. and page no.)

1.1 Para 2.1.2, p.17

Regulations on the use of the autopilot...

IMO Resolution MSC64(67) (Performance Standards for Heading Control Systems) requires a heading monitor which monitors the actual heading in use by an independent heading source.

We think that it should be clearly stated that no such monitoring and alarming facility has been available on board.

1.2 Para 2.1.3, p.21

Type approval for the Anschütz Std.20 ...

Statement:
The Std.20 has been re-certified in the meantime due to hardware modifications. This certification was conducted with the current software version P002.E2.03. The Type approval has been granted, Type approval certificate no. BSH 6297/0032/00.

1.3 Para 2.1.3, p.22

The type approval documents stipulates that all changes made to the equipment or is documentation must be approved by BSH.
Clarification: As per agreement with the notifying body, this rule does not apply for minor modifications on both hardware and software.

1.4 Para 2.1.3, p.23 first para.

The manufacturer of the compass system has not issued instructions about which form should be used for relaying heading information to the autopilot.

Comment:
Raytheon Marine GmbH has not been asked to do project engineering for the subject vessel. In such a case, Raytheon Marine GmbH would have prepared detailed connection diagrams, defining which user should be connected to which output of the gyro system.

IMO Resolution MSC64(67) (Performance Standards for Heading Control Systems) requires the usage of digital serial communication according to IEC 1162.

1.5 Para 2.1.3, p.23 last para.

The compass system manufacturer did not classify the Heating status of the gyro unit as a fault condition.

Statement:
The accident has been caused according to this report by excessive EMV disturbances.
These disturbances have caused the gyrocompass to fall back into the heating mode due to corrupting the temperature signal.

The heating mode is a part of the startup phase of the Std.20. This mode cannot be reached in practice as the dissipating heat from the components prevent that the operating temperature could drop below the threshold, even on a fault of the heating function in conjunction with the minimum ambient operating temperature.
That means the heating mode cannot be reached again afterwards under all regular conditions.
The Std.20 has been designed and manufactured according to the EMV requirements of IMO and all relevant standards, particularly the EN 60945.
Requirement to fulfill these conditions is that the installation on board the vessel is carried out in accordance with our installation requirements, which require e.g. the usage of shielded cables.
It must be pointed out that this condition was abnormal and corrupted the functionality of the gyrocompass including all protective functions.
It has been proven that the Std.20 when installed correctly with respect to all EMV precaution required, such a failure mode could not be reproduced, even under severest conditions, i.e. high energy radiation sources in direct exposure to the gyrocompass equipment.
Until this accident we haven't been aware on this failure mode.

1.6 Para 2.1.3, p.24 first para.

The operation of the step signal depends on the software version of the gyro unit.

Statement:
The step signal is generated in the distribution unit (Compact distributor) which is integral part of the control unit . So the software version of the compact distributor is responsible for the functionality of the STEP signals.

1.7 Para 2.1.3, p.24 first para.

Step signal fault status is mentioned :
On the Step Signal there a definition of a fault status is not existent. The occurrence of an un allowed status is usually treated as invalid, but as there is no common specification, there is no requirement and therefore guarantee that all devices react accordingly.

1.8 Para 2.1.3, p.24 second para.

Software Versions … program updates

Statement:
The changes in the behaviour of the software has been described in the Service Bulletins that Raytheon Marine GmbH has sent out to the service stations, including the Finnish Service Station.

1.9 Para 2.1.3, p.24 last para.

Statement given is not true as explained above. The software on the compact distributors on both vessels must be different.

1.10 Para 2.1.3, p.25

SW P002E02.04

Statement:

This software was an engineering version. It has been never introduced into production. Raytheon Marine GmbH has no intentions to change the density of the supporting liquid.

1.11 Para 2.1.4, p 28, last para.

The actual faults causing the above heading errors in gyrocompass1 may not have been the faults that were addressed during the maintenance visits.

Statement:
Pure speculation !

1.12 Para 2.1.5, p 28

However, all parts of the compass and navigation system were wired and connected correctly with regard to the existing equipment and the requirements of the manufacturer.

Statement:
Assertion is not true. The requirements from Raytheon Marine are not fulfilled at all as unshielded cables have been used. Raytheon Marine GmbH has not been involved in the project engineering at all.

1.13 Para 2.1.5, p 31, item 4.

Statement:
The applied DNV rules are not applicable for navigation equipment.

1.14 Para 2.2.1, p 43 second para.

In summary...

Statement:
All heading repeaters showed dashes instead of a heading value. Especially the digital repeater mounted above the conning station displayed these red dashes noticeably.

1.15 Para 2.3.1, p 48, Gyro fault analysis

Statement:
The FMEA was performed for the Raytheon Marine Integrated Bridge System (IBS) and not for the Std.20 as expressed.
Concerning the disconnection of the outputs, the question comes up if it is reasonable to let a vessel sail with a disturbed heading sensor. In the Raytheon Marine philosophy, it is not.
The Std.20 as every technical system has a limited availability as well as a limited reliability and integrity.
So the potential failure modes of the Std.20 modes have been illustrated and described as
the connected devices have to deal with these failure modes. So the manufacturer of these devices has to make his own conclusion according to his possibilities.
So every system integrator (in this case Polartec / STN Atlas) has to create such an FMEA to assure maximum reliability and integrity of a navigation system.
Up to the DNV requires FMEA only on one man bridges.

1.16 Para 2.3.2, p. 49, International regulations

Statement:
As already said, IMO Resolution MSC64(67) (Performance Standards for Heading Control Systems) requires a heading monitor which monitors the actual heading in use by an independent heading source.
If have been followed this IMO resolution, the usage of an independent heading monitor with an independent heading sensor like a TMC could have prevented the accident.

2 Finnfellow-Report - Assessment concerning EMC and Type Approval

2.1 Statements on EMI*

The statement in the summary that the radio frequency interference is the reason for the failure of the Standard 20-System cannot be accepted. This error cause is in no way confirmed by the examinations of the commission.

2.1.1 Reason

a) Statement of the Captain of the Finnfellow

As Captain Matti Ahti told us during service operation onboard the Finnfellow, no disturbances or malfunctions were detected at the compass system at any time which would lead to the assumption that there was an influence by radio frequency interference.

b) EMI onboard the ferry "MS Finniar"

The assumption of the commission that EMI may be the cause for the failure of the Standard 20 onboard the "MS Finnfellow" is based on the observation of the Standard 20 compass system onboard the ferry "MS Finniar".

Onboard the Finniar influences of the compass system by electromagnetic fields were detected.

As already stipulated in the service report of March 15, 2001 these influences were caused by improper installation of the compass system.

c) EMC-tests in Tampere (Chap. 4.1 / p. 31)

The EMC-tests performed in Tampere cannot be accepted as evidence for the insufficient immunity to radio frequency interference of the Standard 20.

The tests were not performed according to the Standard and the compass was disassembled during the test (motherboard outside the gyro).

d) EMC-tests in Kiel (Chap. 1.4.2 / p. 10)

During the test conforming to the Standard EN 60945 no influences on the Standard 20 could be detected.

Influences on the temperature sensor in the Standard 20 could only be achieved when the commission gave the instruction to increase the test level by 4 to 10 times and to change the test setup contrary to the standard. A failure of the Standard 20 as onboard the Finnfellow could not be achieved.

2.1.2 Type Approval for the Anschütz Standard 20 Gyrocompass (Page 21, 22)

The statements which were made on the type approval are correct. Additionally the following notes:

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* Electromagnetic Interference

a) We have an agreement with the BSH that minor changes are not reportable. The minor changes of the software behind the dot have been registered, e.g. P002 E02.01

b) The software version P002 E02.01 which is in place onboard the Finnfellow has been type approved by the BSH in the meantime.

c) The compass system Standard 20 has subsequently passed a new EMC-test according to the EN 60945, status 9.1997 (see enclosure).

d) Type Approval Tests (Chap. 3.3, P. 58)

- The Standard 20 has passed the EMC-test "Radiated Interference" within a frequency band of 80 MHz to 2 GHz with 10 V/m.
- This frequency band is not required by the EN 60945.

2.1.3 Shielding against Interference, (Chap. 2.4, P. 51)

The influences detected onboard the MS Finniar were caused by the improper installation. The additional shielding is not necessary under normal board-conditions.

2.1.4 Evaluation of the Report concerning EMC

The report makes the impression that the commission has had a preconceived opinion to the failure cause of the Standard 20 due to the observed EMC-influences onboard the MS Finniar. The partly unqualified tests were made to confirm this opinion.

It is perfectly sensible to determinate the limits of the immunity to interference of the Standard 20 by increasing the radio interference level. However, it is in no way correct to test the disassembled compass for immunity to interference in order to state in the report: "Influences on the compass have been detected".

3 Comments on 3. - Conclusions

3.1 Para 3.3., p.58, second paragraph

Statement:
The IMO Resolution MSC64(67) (Performance Standards for Heading Control Systems) requires a heading monitor which monitors the actual heading in use by an independent heading source. Such a monitor would have detected the heading error and have alarmed the crew.
The vessel has not been equipped with such a device, which makes this a root cause of the accident.
A defective system can not monitor itself by 100%, that is why an independent source is required.

3.2 Para 3.3., p.59, forth paragraph

Installation instructions

Statement:
Raytheon Marine GmbH entertains a project department (commercial sales) consisting of engineers and design poeple, who are doing cable and wiring diagrams for individual sales orders.
The gyro manufacturer has not been involved nor in the survey of the sitution on the FINNFELLOW before the renewal of the equipment nor after the renewal of the equipment nor in the project engineering phase.

4 Para 4. – Recommendations

4.1 Para 4.1. p.63, item 1.

Statement:
Raytheon Marine GmbH already recommends to use shielded cables only.

4.2 Para 4.2. p.64, item 4

Statement:
It has to be made sure, that the actual regulations are followed, i.e. that there is an independent source for heading monitoring.
Furthermore Raytheon Marine GmbH recommends the implementation of a track monitoring alarm, whenever a preplanned track / route is used in conjunction with an autopilot or trackpilot.
In addition to this, an integrated navigation system should be approved by the classification society, independent of new installations versus renewal of systems, i.e. a survey should to be made after each change of the system including a FMEA which is individual to the installation.

We hope that our comments are helpful in the making of the investigation report.
If you should have any further question and comment, pls. do not hesitate to contact us again.

As the maker of navigational sensors and systems, we are aiming for an improvement of these systems.

With best regards,

Ulrich Schuster
Asst. Managing Director
Raytheon Marine GmbH

Appendix 8

SAM Electronics
Member of the EuroMarine Group

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z.Hd./Attn.:	Mr. Martti Heikkilä	Date: 09.11.01
Fax:		Pages: 1 of 2
Von/From:	Dr. M. Westphal	Copy:
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Ref.: Request for comments 01.10.01

MS "FINNFELLOW" GROUNDING IN ALAND ON APRIL 2,2000

Dear Sirs,

Thank you very much for the report received and the opportunity provided to us to comment.

The following comments have been evaluated based on the final draft/investigation report B 2/2000 M of the Finnish Accident Investigation Board (*your original text in italics*). We kindly propose to consider our remarks in order to finalize the report.

Page 37:

The system could not interpret the significance of the various numeric values for the officers on watch.

For the actual situation (15 seconds after the jamming of the heading) this sentence could be misleading because a CMG of 85.5° could have been realistic due to other influences (Drift Angle to STB, wind from North). Therefore we propose to delete the a.m. sentence in this connection.

Page 44:

The autopilot slowed down the vessel's speed ...

We propose to substitute this sentence by: **The vessel's speed slowed down due to turning.**

Page 44:

The recorded position was therefore outside the **assumed** *true contour of the ship.*

We propose to add this, because it is an assumption concerning the real position of the vessel as a result of the simulation.

Page 46:

The rotation of the radar video anticlockwise was the only indication of the malfunction.

Not only the radar video indicates a malfunction, also the unexpected starboard rudder (a counter-rudder to port should be expected after a starboard turn) and the ongoing change of the CMG to starboard at a constant heading indicated a problem.
Furthermore the ship was turning to starboard although a rate of turn = 0 was indicated.

Page 57:

... the heading information to the autopilot was entirely false.

We propose to replace *entirely* by "**increasingly**".

Additional comments:

- The screen shots of the displays taken during the simulation were done with not activated Trackpilot – this should be mentioned in the report. Therefore no deviation bars for course and track are visible, which could have indicated a constant course error and the increasing track deviation during the jamming period.

- We are not sure how the simulation did influence the realistic display of the XTD (off track distance) to the pre-planned track, which should have been increasing considerably to "right of the track" based on the correct position information.

In case of any further questions please do not hesitate to contact us.

Best regards,

STN ATLAS Marine Electronics GmbH
Systeme Navigation, Kommunikation

Dr. M. Westphal