Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Bundesoberbehörde im Geschäftsbereich des Bundesministeriums
für Verkehr, Bau und Stadtentwicklung

Investigation Report 174/10

Serious Marine Casualty

Grounding of the

MV BELUGA REVOLUTION

off ENUS (Tench) Island

in the South Seas

on 30 April 2010

1 August 2011

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

This 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 this Investigation Report.

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1 Summary of the marine casualty

The BELUGA REVOLUTION was fully laden with 8,030 tons of scrap metal and sailing from Noumea in New Caledonia to Pohang in South Korea. The navigator calculated the voyage plan for Noumea to Pohang; the total distance was 4,225 nm and the planned duration 11 days.

In addition to the required navigation equipment, the bridge was equipped with an electronic chart system to supplement the charts in paper form.
On 30 April, the vessel was located to the north east of the Bismarck Sea in the South Pacific Ocean. It was steered on autopilot and moving at 16 kts. At no point did the 3 officers on watch or the master notice that from the last waypoint at 1800[1], the track practically led over Tench Island. The BELUGA REVOLUTION grounded on ENUS (Tench) Island at 2210 in a westward setting South Equatorial Current and tropical showers, which blurred the radar image.

The shell plating was dented and the forepeak cracked as a result of the vessel grounding. There were no injuries and no pollutants escaped.

[1] All times shown in this report are ship time = UTC + 11 h

2 SHIP PARTICULARS

2.1 Photo

Figure 1: Photo of the vessel − vessel operator

2.2 Vessel particulars

Name of vessel:	BELUGA REVOLUTION
Type of vessel:	General cargo vessel
Nationality/flag:	Germany
Port of registry:	Elsfleth
IMO number:	9267742
Call sign:	DDGA
Owner:	Beluga Fleet Management GmbH & Co. KG
Year built:	2005
Shipyard/yard number:	Bodewes Scheepwerf Volharding Foxhol BV, 549
Classification society:	Germanischer Lloyd
Length overall:	134.61 m
Breadth overall:	21.50 m

Gross tonnage:	8,963
Deadweight:	10,581 t
Draught (max.):	7.95 m
Engine rating:	7,200 kW
Main engine:	Caterpillar Motoren GmbH & Co. KG
(Service) Speed:	17.65 kts
Hull material:	Steel
Hull design:	Double bottom
Minimum safe manning:	12

2.3 Voyage particulars

Port of departure:	Noumea, New Caledonia
Port of call:	Pohang, South Korea
Type of voyage:	Merchant shipping/international
Cargo information:	Scrap
Manning:	17
Draught at time of accident:	7.9 m

2.4 Marine casualty or incident information

Type of marine casualty/incident:	Serious marine casualty, grounding
Date/time:	30/04/2010 2210
Location:	Enus (Tench) Island, Saint Matthias Group
Latitude/Longitude:	φ 01°39.0' S λ 150° 40.7' E
Ship operation and voyage segment:	Open sea
Place on board:	Underwater hull
Consequences (for people, ship, cargo, environment, and other):	No injuries, shell plating dented, forepeak cracked no pollutants escaped

Excerpts from nautical charts BA 4622, AUS 462, ARCS. Source: BSH ORCA system with plotted positions from the radar recordings of the BELUGA REVOLUTION's VDR

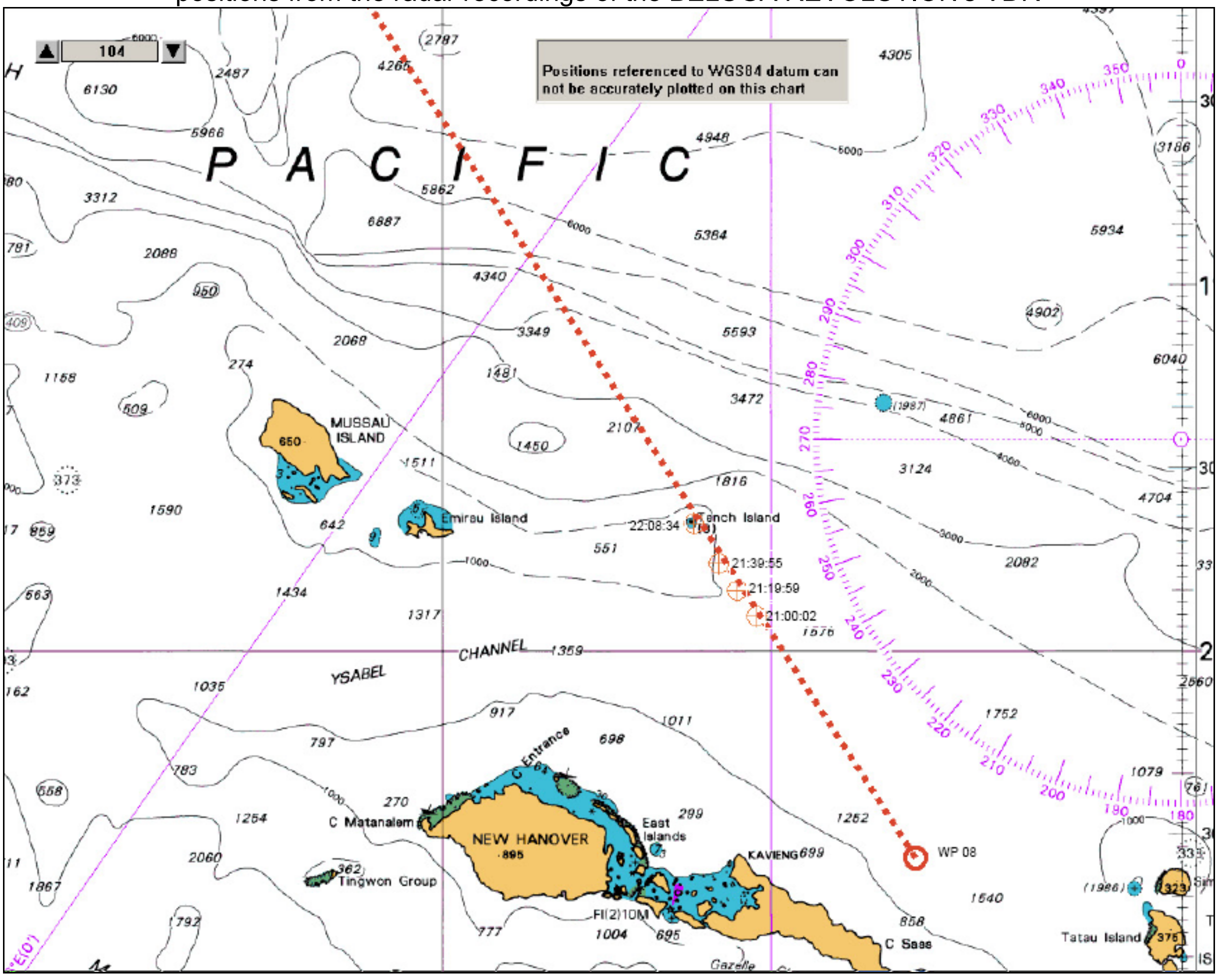

Figure 2: Nautical chart BA 4622 ARCS. Source: BSH

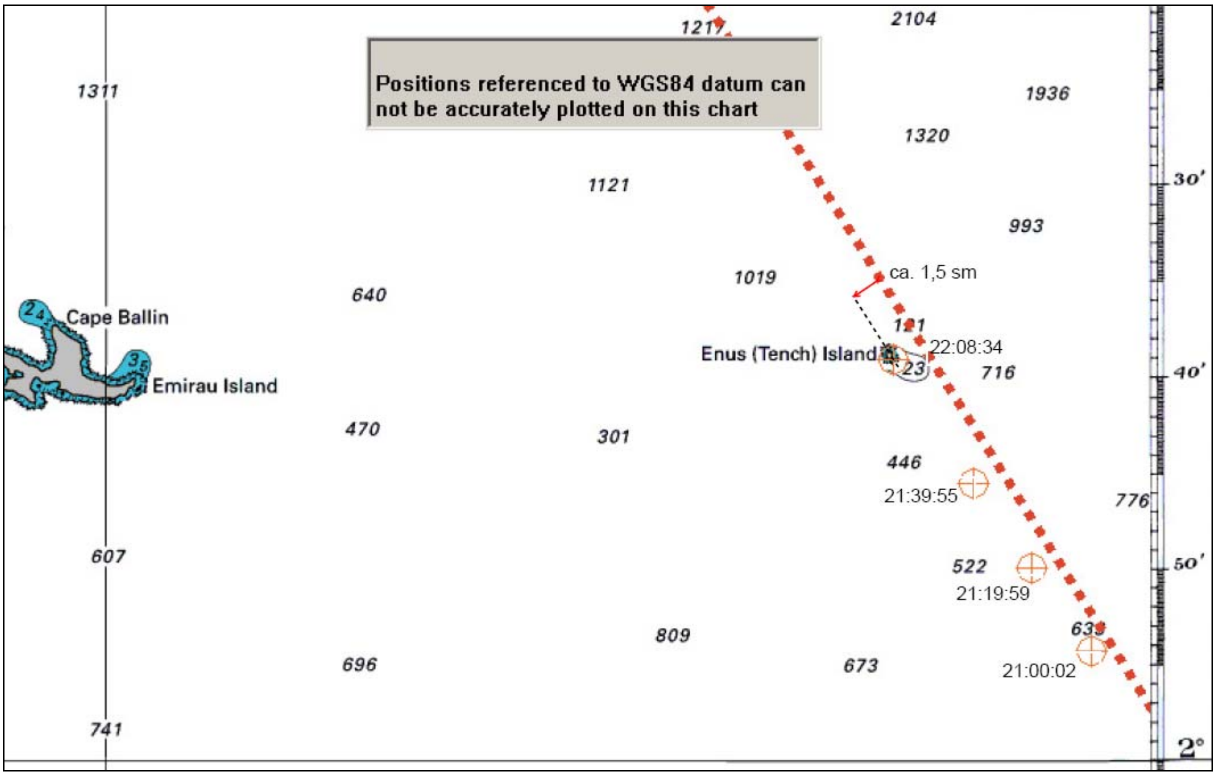

Figure 3: Nautical chart AUS 462 ARCS. Source: BSH

2.5 Shore authority involvement and emergency response

Agencies involved:	Authorities of Mussau Island and Kavieng
Resources used:	Svitzer, the tug MC LARTY (Pacific Towing), the tender Celeste
Actions taken:	Hauled free, underwater inspection
Results achieved:	Refloated

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

The account of the accident is based on an expert opinion drawn up for the vessel operator by the company Australian Marine Inspections, Nautical Surveyors and Marine Consultants.

The BELUGA REVOLUTION was on a voyage from Noumea in New Caledonia to Pohang in South Korea with scrap metal on board. She departed from Noumea on Monday 26 April at 1800. The navigator prepared the voyage plan (Beluga Fleet Management Form 44) for the voyage from Noumea to Pohang.

In addition to the required navigation equipment, the bridge was equipped with an electronic chart system (ECS with ARCS raster data) to supplement the charts in paper form. Nautical chart BA 4622 – Admiralty Islands to Solomon Island, Issue No. 2, published 2003, was used at the time of the grounding. The chart had been updated according to the Notice to Mariners up to week 03/10, most recently with correction No. 728/10 and temporary message T 273.

The events that led to the grounding are based on statements of the crew or taken from the log book of 30 April as follows:

1200 Position (POS) at midday 03°33.3' S, 152°32.0' E (GPS); gyrocompass heading (GYH) 310°, track (TRK) 307°; officer on watch (OOW) hands watch over to replacement, from 1230 another OOW takes over the watch until 2000 by way of exception

1600 POS GPS 02°53.4' S, 151°42.7' E, GYH 309°, TRK 307°;

1800 POS GPS 02°37.0' S, 151°17.6' E; OOW changes GYH to 328°, TRK 327°

2000 POS GPS 02°07.1' S, 150°59.9' E, GYH 330°, TRK 322°[2]; OOW hands watch over to replacement

2100 Master enters the bridge, takes over from the OOW and starts to transmit reports to the vessel operator from the radio station

2200 OOW returns to the bridge and takes over the navigational watch; master enters GPS position 01°41.3' S, 150°42.0' E on the chart. Neither the master nor the OOW noticed that the position entered is very close to Tench Island.

[2] This entry is erroneous. The calculated track was 327°.

2210 The vessel runs onto a reef south-east of Tench Island, POS GPS 01°39.07' S, 150°40.17' E, GYH 330°, TRK 322°, only 2.2 nautical miles away from the position at 2200.

At the time the vessel grounded, she was steered on autopilot with a gyrocompass heading of 332°; the track was 327°. At no point did the 3 officers on watch or the master notice that from waypoint 8 to waypoint 9, the track practically led over Tench Island.

The shell plating of the forepeak was dented and cracked due to the vessel grounding. Fuel was bunkered in two deep tanks between cargo holds 1 and 2 and protected by double bottom ballast tanks and side ballast tanks. At no point was there a risk of oil pollution. The only outer tank that contained oil was at an elevated position aft on the starboard side behind the engine room and it was unlikely it would be damaged.

During the afternoon and evening of 3 May, when experts arrived at the vessel, talks were held between the owners, insurers and company Svitzer with respect to the salvage operation with the tug MC LARTY. It was necessary to prevent the vessel from being pushed even closer to the shore by swell coming from NE. The swell strengthened after dusk set in before calming again at dawn.

The master stated that the vessel moved considerably before, during and after the onset of high tide, which indicated that she was not fixed in place as firmly as other people, who were not at the scene, assumed. On Monday 3 May at 2215, the master was granted permission by the owners to receive a tow line from the tug MC LARTY and begin lightering operations on the port ballast tanks in order to make an attempt at refloating the vessel at high tide on 4 May at 0409.

This was carried out properly with the support of the vessel's own engine and the tug MC LARTY at dawn on 4 May. The vessel was almost completely afloat, only the bow was still in contact with the reef; the middle of the vessel was at right angles to the reef. The salvage attempt was halted at 0559. The tug MC LARTY was instructed to stay in position and keep the stern towards the swell and in deep water. At this point, a decision was made to fill the aft ballast tanks during the course of the day. A second attempt to refloat the vessel was to be made two hours before the next high tide on 5 May at 0430.

The ballast operations were carried out during the day according to requirements, but the bow still seemed to be aground at a depth of about 1.5 m. It was found that the shell plating on tanks No. 1 WB DB and No. 2 WB DB on the starboard side was torn and that water was entering there. On 5 May, shortly after 0100, the vessel began to move. Following that, the tug master slowly increased the tension to 85%. At 0146, the vessel glided gently from the reef and at 0500 the tug was released.

At 0537, the vessel began the passage to Kavieng at 8 kts under her own power with the support of the tug MC LARTY and the tender CELESTE.

The vessel anchored off Kavieng on 5 May shortly before midday. On the afternoon of 5 May, while the vessel was still at anchor, the diving team of the tug MC LARTY carried out an inspection with cameras. The results were as expected: significant damage to the bottom of the forepeak, two cracks in No. 1 WB DB and one in No. 2 starboard WB DB.

On the morning of 6 May, the reef on which the vessel had grounded was inspected and talks were held with the 20-30 remaining residents of the island. 80-90 residents were evacuated 18 months earlier after heavy seas flooded the island with salt water during a spring tide.

On 7 May, permission was granted to proceed to sea after negotiations with the authorities in Kavieng and a survey by Germanischer Lloyd. This was subject to certain conditions. At 2030, the vessel proceeded to Pohang, the port of destination in South Korea, at reduced speed and without there being any requirement for repairs.

3.2 Investigation

3.2.1 Statements

In early April, the navigator was reportedly informed that a charter from Noumea to Inchon had been arranged for the end of the month; the cargo was scrap metal. At that point, the BELUGA REVOLUTION was proceeding from Surabaya, Indonesia, to Gove, Australia, and then on to Vavouto, New Caledonia. The Noumea/Inchon route was reportedly pre-planned roughly using the electronic chart system (ECS). Two weeks later, while unloading cargo in the roads of Vavouto, the Noumea/Pohang voyage plan was reportedly finalised using paper charts during the night watch from 2400 to 0600. While entering the courses on the chart, it was reportedly not noticed that the course line was only 1 nm away from Tench Island. On 30 April from 1155 to 1230, the OOW reportedly took over the navigational watch and sent reports to the vessel operator and the weather service, tested the GMDSS equipment and checked the radio logbook. After that, he was reportedly off duty until the time at which the vessel grounded. The other OOW's were already there when he reportedly arrived on the bridge after the accident. By all accounts, swell and rain clutter was visible on the radar screen. The deviation of the track in the GPS receiver and the ECS was reportedly about 1 nm.

In the afternoon of 30 April the OOW reportedly kept the vessel close to the course line, as recorded on the paper chart and the GPS receiver. He reportedly detected no navigational hazards during his watch until the time at which the watch was handed over at 2000 and expected no incidents during that period.

At 2000, the OOW reportedly took over the navigational watch from his predecessor. The navigation equipment was reportedly working properly. The track reportedly corresponded with the voyage plan and was said to have been recorded on the paper chart, ECS, and GPS. He reportedly did not receive any warning regarding Tench Island, which was about 30 nm ahead. In the period between 2000 and 2100, the weather conditions were reportedly mostly good. It is said that the sky was partly cloudy and overcast with rain clouds. The lookout was reportedly in the starboard wing. By all accounts, no targets were identifiable on the radars (S and X-Band).

Due to the ocean passage and small map scale, the positions were reportedly entered every 2 hours. The next entry was to be made at 2200. At about 2100, the master reportedly entered the bridge to relieve the officer on watch (OOW) for one hour and because he was expecting correspondence with the vessel operator (the time difference to the vessel operator was 9 hours). The OOW reportedly provided information about the course and position, but not the fact that the track would almost pass over an island. No dangerous object or any warning or comment about Tench Island was found on the small scale chart.

Since there were some small fishing boats nearby and heavy rain showers formed during the navigational watch, the radar screens were reportedly continuously monitored. It was reportedly not possible to differentiate a cloud from an island on the screens because of the low clouds. Moreover, an island was not expected. Following that, the master stood the OOW down and then performed administrative work and prepared for the handover in Pusan, where the change-over was to take place. The OOW reportedly returned to the bridge at 2200. The master reportedly gave instructions to maintain the steered course. By all accounts, nothing was visible. It was said that a little rain clutter could be seen on the radar screens. The master reportedly gave no warning about the approaching island. After the handover, he reportedly wished good watch and left the bridge.

Shortly after, the vessel ran aground off Tench Island. The ensuing actions reportedly took place in accordance with good seamanship and the emergency plan. It could not be clarified whether the bridge was continuously manned with a lookout after sun set. In this regard the statements are contradictory.

3.2.2 Damage (GL)

The survey took place on 5 May 2010. No malfunctions were found on the main and auxiliary engines, bow thruster, gear unit, stern tube or safety equipment while sailing to the Kavieng roadstead, which is located 41 nm to the south of the scene of the accident. The underwater inspection revealed dents on the port side between frames 111 and 178 as well as damage to the shell plating on the forepeak and double bottom tanks (DB) 1 centre, 2 port and starboard, and 3 port. While the vessel was hauled free, the forepeak and DB 2 starboard were pumped with 0.5 bar pressure. The draught after the salvage operation stood at 7.8 m. The transverse forces had reached 58% and the bending moments 84%. Bunker reserves totalled 462.9 tons. The vessel was permitted to proceed to Pohang under these conditions in order for the vessel to be repaired there, with the proviso that she would sail at a reduced speed of 13 kts.

3.2.3 Crew and rest periods

The bridge crew consisted of two experienced senior officers (management level) and two junior officers (operations level) of German, Bulgarian and Ukrainian nationality as well as Ukrainian watchkeepers. In addition to the required radar simulator courses, the officers have attended certified courses on the electronic chart.

The formal watch roster conformed to the recommended three-watch system in IMO Resolution A. 890 (21) Principles of Safe Manning and the requirements of the ILO. Accordingly, rest periods at sea were observed every day. There is no evidence to suggest that the seamen were not rested. It was exceptionally deviated from the formal watch roster in the afternoon of the day of the accident because of a board festivity. Here, the time sheets and the log book entries were inconsistent in comparison with the statements.

3.2.4 SMS and voyage planning

In addition to the individual duties of the navigational watch according to STCW[3] and COLREG[4], the duties of the master, who is responsible for giving specific instructions to ensure proper operation, are also laid out in the safety management system (SMS) of the BELUGA REVOLUTION. Safe navigation is incumbent on the officer on watch. He may not deviate from the planned track without the consent of the master, unless there is imminent danger. When on the open sea, the position of the vessel should be recorded at intervals of two hours and the deviation from the course line should not exceed 0.1 nm. When the watch is handed over, information on the position, course, speed, expected course changes, hazards and weather conditions as well as

[3] STCW Code A and B, Chapter VIII, standards relating to watchkeeping duty
[4] Regulations for Preventing Collisions at Sea

instructions of the master should be passed on to the replacement. In addition, the operating state of the navigation equipment, such as compass errors and the traffic situation are to be made known. All existing resources should be used for position fixing and checked against each other as far as relevant. The position must be recorded on the chart as well as in the daily/bridge log. The course and speed must be checked and compass errors determined. Autopilot should normally be used for steering when at sea. The lookout should make a round of the vessel to check for safety issues before or after his watch; this check must be recorded in the logbook. The engine room is unmanned outside of normal working hours at sea.

All officers on watch responsible for navigation are to be briefed fully on the course of voyage and emergency plans. The master delegated voyage planning to an officer on watch at his discretion and according to his specifications. Voyage planning includes the compilation and evaluation of all information relevant to the voyage as well as planning, execution and control. Before voyage planning is carried out, the master makes a final assessment together with the officers on watch. Here, sailing directions, draught, loads on and manoeuvring characteristics of the vessel, tides and currents, shallows and hazards, weather conditions, navigation aids and their accuracy, type of position fixing and intervals thereof, traffic situation, warnings, prohibited areas, anchoring, emergency plans and bunker reserves are to be included.

When using radar, the parallel index lines should also be considered for navigation. The paper chart should be used in conjunction with the electronic chart system (ECS)[5]. The paper chart is not required if an ECDIS[6] is present if the sea area is covered by an ENC[7]. An RCDS[8] with official chart data should be used in conjunction with the paper chart if no ECS is present. Attention should be given to a sufficient view of the area ahead and the next chart to be used. Hazards are to be entered in both systems. Unofficial chart data may not be used for voyage planning. Voyage planning must be recorded. The navigator carries out the voyage planning on the basis of charts and sailing directions. Monitoring of the planned tracks is an ongoing process for all officers on watch. In cases of doubt, the master must be informed immediately. Use should be made of the weather briefing via the vessel operator before departure, and weather reports obtained every 12 hours. This information should be included in the voyage planning. The itinerary is made available to the weather information service in due time for that purpose.

[5] Electronic Chart System
[6] Electronic Chart Display and Information System
[7] Electronic Navigational Chart
[8] Raster Chart Display System

3.2.4.1 Voyage planning and weather

On the voyage planning data sheet for Noumea to Pohang, routing charts BA 5127 and BA 5128 for the months April and May, which take into account the wind and current conditions, Sailing Directions NP 60 for the South Pacific and NP 136 (Ocean Passages for the World) as well as Chart AUS 462 or similar publications for voyage planning are absent. In NP 60 and the above routing charts, the westward setting South Equatorial Current is indicated to be 1-1.5 kts at Tench Island. In April, the swell can reach up to 4 m, mainly from directions between the SE and NW. In the sailing directions, Tench Island is described as being 2-3 nm SW of the charted position in Chart AUS 462 (reported 1987). The island is forested and with the exception of the SW side surrounded by reefs, which reach about 1.5 cbl into the ocean. Possible routes across the ocean are recommended in NP 136. According to that, the St. Matthias group of islands would be passed either to the east of Tench Island, New Hanover and the Tabar Islands or west through the Bismarck Sea. In Routing Chart BA 5127, only the northern variant is recommended at some distance. The German Handbook of Ocean Passages, BSH 2057, also recommends passing to the east or west of New Hanover, but not necessarily to the east of the Tabar Islands. A tropical climate prevails there. Heavy showers and thunderstorms occur several times a day at air and water temperatures of around 28° C as well as light winds in the intertropical convergence zone (doldrums) and cloudiness. Tropical typhoons do not occur in parallels up to 4° from the equator or in the sea area NE of New Guinea.

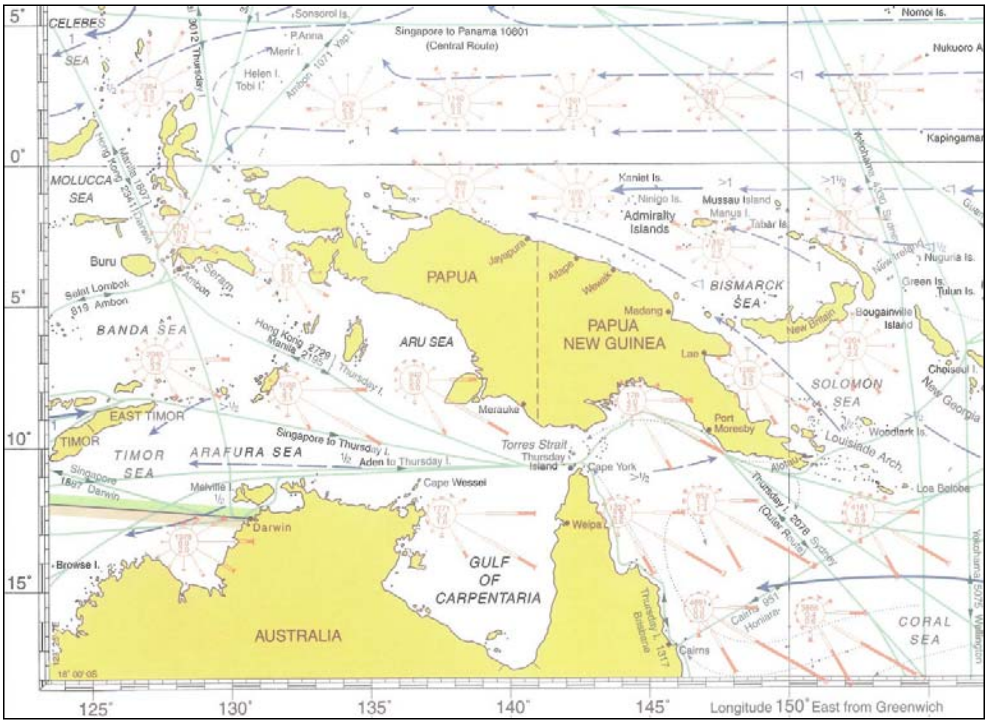

Figure 4: Excerpt of Routing Chart BA 5127 April

4 ANALYSIS

Sailing directions, charts, and the route from Noumea to Pohang, including waypoints, courses and distances, are recorded in the BELUGA REVOLUTION's voyage planning. Routing charts used and sailing directions about ocean tracks were not recorded. The valid routing chart in each case had always been below a transparent sheet covering the chart table. Consequently it was reportedly visible at all times. From waypoint 8 (02°33.8' S, 151° 16.8' E), a rhumb line of 327.4° and 2,301.8 nm was calculated for the track to waypoint 9 (29 ° 44.5 'N, 129 ° 48.1' E). At about 22 nm SE of Tench Island, the chart should have been changed to AUS 462, which was also performed by the ECS. When changing charts with ARCS data, the alarm 'NO OFFICIAL DATA' is triggered on the TRANSAS 2400 ECS. It is no longer possible to establish whether the vessel's position was switched back to after that. At 2100, Chart AUS 462 was already in use (see Fig. 2, vertical magenta line indicates the chart boundary).

According to the analysed hard disk data, the revision status of the Electronic Chart used, AUS 462, corresponded to 11 February 2010. In the simulation on the TRANSAS 2400 system on 2 December 2010 using original data from the BELUGA REVOLUTION, here in daylight mode for better readability, Raster Chart AUS 462 is displayed with a scale of 1:400000 (see Fig. 5).

In the manner charted during the voyage, the system was presumably operated in auto scale mode, i.e. with a scale of 1:750000 (reference parallel 4°) and thus even smaller than shown here. According to the ECS data, it is evident that shortly before the grounding about 5° was maintained in order to keep to the track of 327°. The drift displayed is 254.2° and 1.4 kts. This involves calculated values of the GPS receiver from the COG, SOG and the heading from the gyrocompass. A dual axis log, which measures the longitudinal and transverse velocity in real time and uses that to calculate the drift, was not installed.

It was possible to establish from the electronic logbook that at 2041, about 1.5 hours before running aground, the zoom feature was used to lower the scale to 1:500000. The zoom feature was used again after the accident at 2214. The smallest scale when zooming on this chart would be 1:300000. So-called watchdog features, which monitor a sector ahead of the electronic chart, cannot be generated when using raster data. Therefore, an alarm could not be triggered from chart data. It was not possible to establish whether the echo sounder was switched on. The VDR did not record data (see Fig. 9). It is possible that it would have emitted an alarm when falling below the minimum depth set. It should be noted that the charted depth in AUS 462 is in fathoms, and not, as shown in the replay system, metres.

It is no longer possible to determine the settings with which the ECS was operated at time of accident because this information was recorded by neither the VDR nor the ECS. Since an ECS was in use and not an ECDIS, the officer on watch would have been legally obliged to navigate using the paper chart.

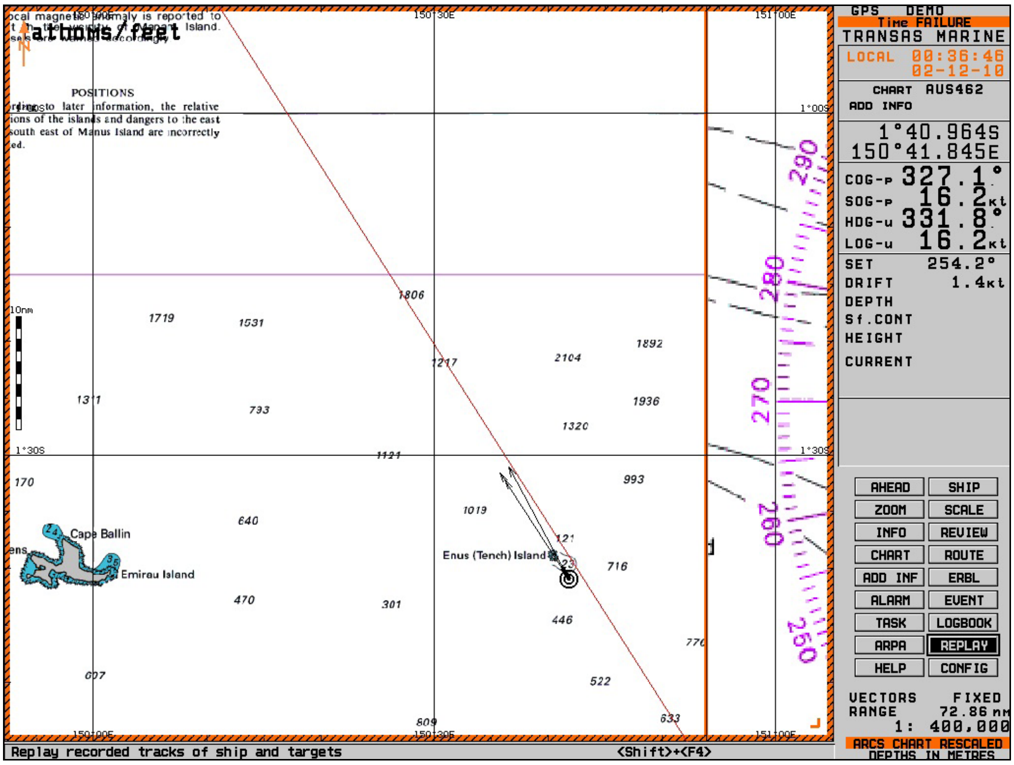

Figure 5: Source: Replay system − Transas Marine International

The paper chart in use was BA 4622 at a scale of 1:1500000 (reference parallel 23°). It is based on the reference system WGS 84, but the scale is twice as small as AUS 462. It is possible that the paper chart AUS 462 was not on board. Information about the geographical position of Tench Island in the English Sailing Directions NP 60, 11th Edition, completed 11 October 2007, does not correspond with the plotted position of the island in charts AUS 462 and BA 4622. It is noted on the chart that GPS positions in reference system WGS 84 are not given precisely on the chart and that differences can be substantial. The shipboard NP 60 displays the position as 01° 38' S 150° 43' E and an indication that the island lies 2.3 nm SW of the position mapped on Chart AUS 462. The chart was issued by the Australian Hydrographic Service (AHS) on 5 November 1992 and is based on a British chart issued on 11 June 1934. The source in NP 60 refers to reliable information from the year 1987 and was the most recent available source before the book was printed. In an edition of the official electronic chart ENC cell AU302150 of 21 May 2010, the AHS maps the centre of the island at the position 01°38.9' S 150°40.5' E. In the charts AUS 462 and BA 4622 as well as ARCS, the island is mapped at the position 01°38' S 150° 40' E. In this respect, the information from the NP 60 and the charts is inconsistent. The UK Hydrographic Office has stated that the shipboard NP 60 will be adjusted accordingly.

At 2200, 10 minutes before the grounding, the paper chart in use, BA 4622, contained a recorded position which is exactly on the course line about 2 nm SE of Tench Island. Prior to that, the positions were entered at 2-hourly intervals in accordance with procedural instructions. According to the photo taken by the expert, these were all on the course line. The last course change occurred at 1800 from true 307° to 327°. If the course of 307° was maintained to the 2° S parallel and about 2130, the track would have run between the islands Emirau, Mussau and Tench at a distance of about 20 nm. It is apparent that none of the officers on watch questioned the courses recorded in the charts. According to the logbook, the vessel was steered between 2° and 3° E after the course change at 1800 to maintain the course line and in response to the westward setting South Equatorial Current. Here, 1 mm corresponds to about 1 nautical mile on the parallel of 2°.

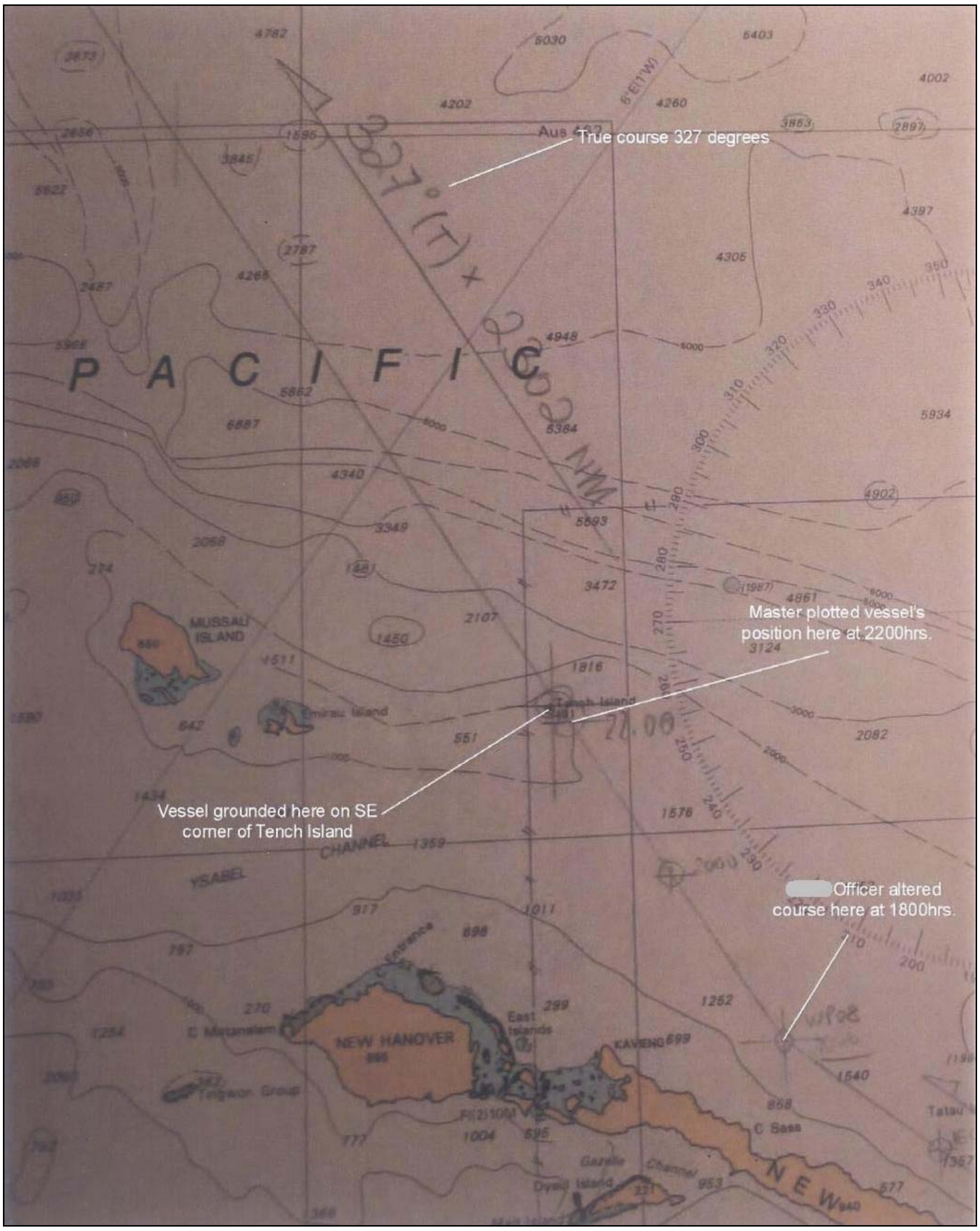

Figure 6: Nautical chart BA 4622. Source: Photo Australian Marine Inspections

GPS accuracy

While analysing the data, it became apparent that with regard to the geographical positions, there were inconsistencies between logbook entries, VDR recordings, charts and sailing directions. According to the expert opinion and logbook entry, the scene of the accident did not match the position of the radar recordings made by the VDR (Fig. 7). It is possible that this was on account of the navigation equipment on board or a recording error in the logbook. Therefore, the quality of the received GPS signals was verified. In the case of the GPS signals, there were no irregularities on the day of the accident. In the figure, the error is shown as 4-8 m with a probability of 95% (Fig. 8). Moreover, a comparison of recorded AIS data of the BELUGA REVOLUTION and UNITED TENORIO at 2046, when both vessels passed one another (Fig. 9), revealed no irregularities in terms of the positions.

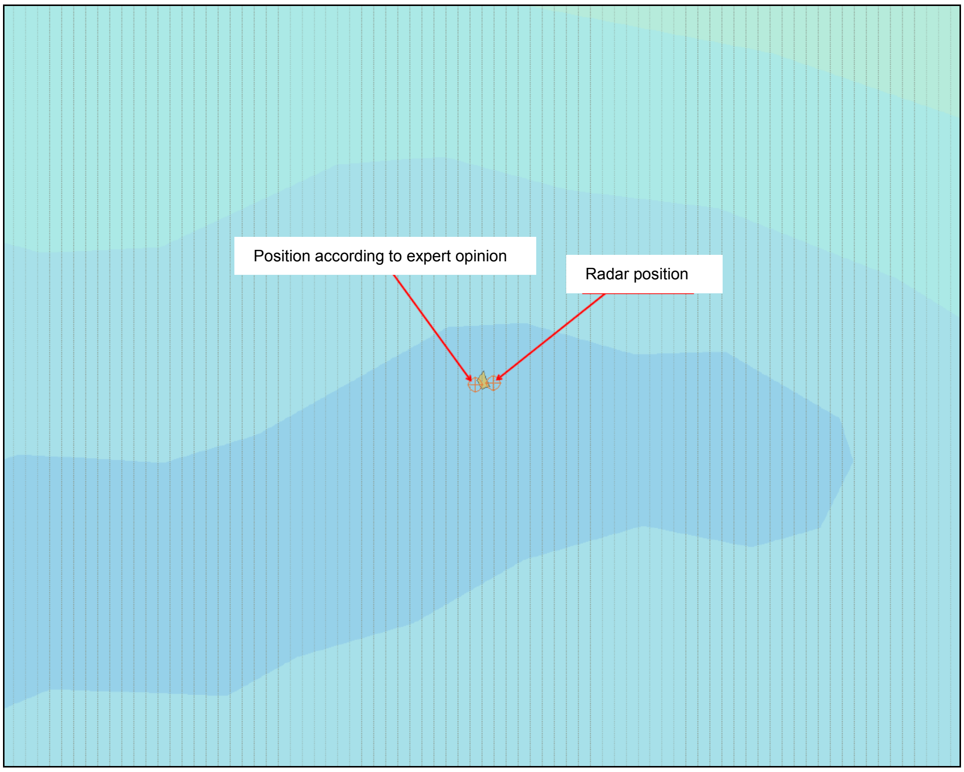

Figure 7: Source: BSH, Chart AUS 462 ARCS, ORCA System

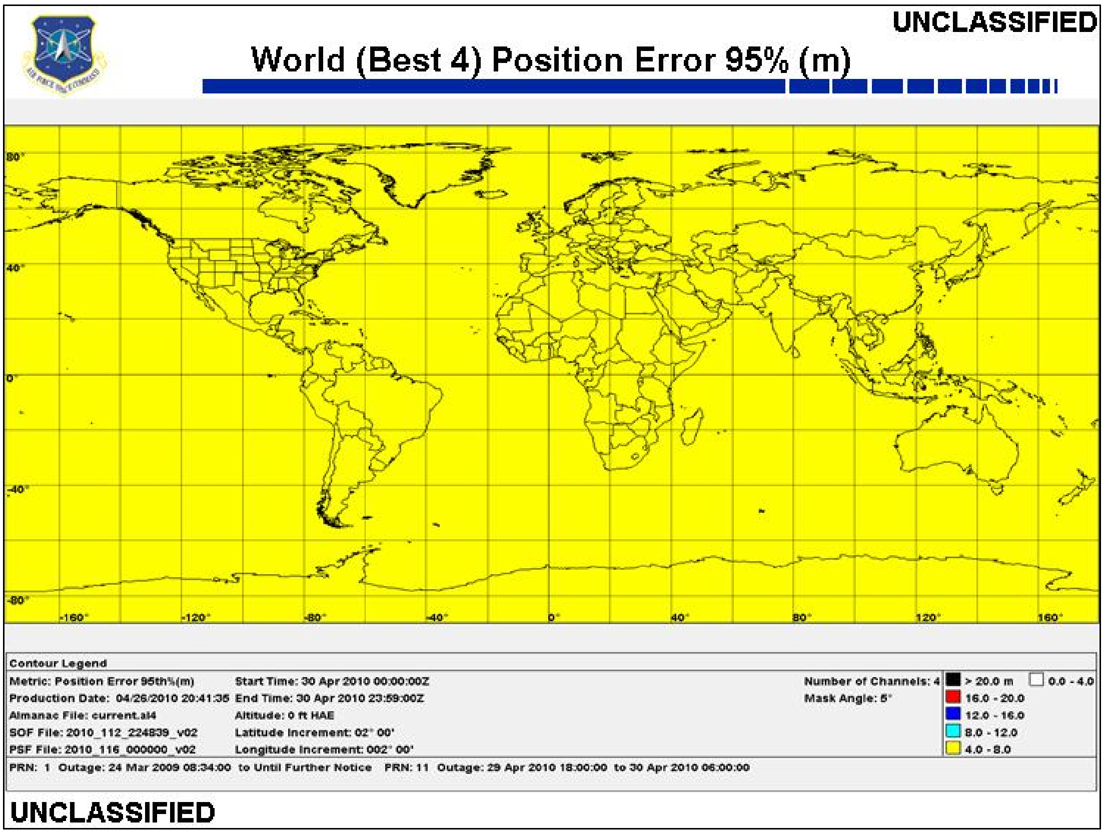

Figure 8: Source: GPS Operations Centre

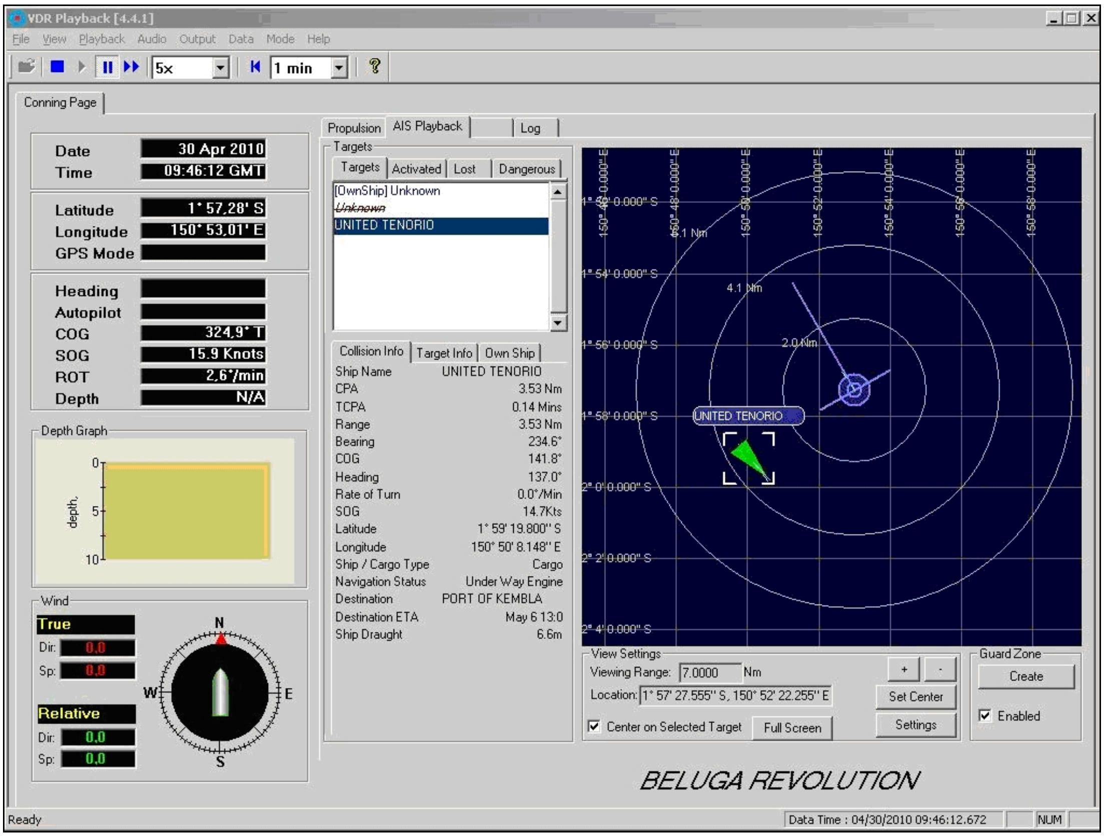

Figure 9: Source: BELUGA REVOLUTION's VDR

Navigation equipment

Magnetic Compass:	Cassens & Plath, Type 11, S/N A 140388
Gyro Compass:	Raytheon Marine GmbH, Type 110-231, S/N 6550
Echosounder:	L-3 Communications ELAC Nautik GmbH, Type LAZ 5000
Speedlog:	12E Diffusion, Type Anthea
Navigational Lights:	Den Haan Rotterdam B.V., Type DHR70N
GPS:	Simrad Stovring AS, Type SIMRAD GN33 GPS/DGPS Navigator
Autopilot:	Raytheon Marine GmbH, Type Pilotstar D
AIS:	Saab Transpondertech AB, Type Saab R4 AIS Class A Transponder System
VDR:	Rutter Technologies, Type 200 G2S, S/N 20108011805
ECDIS:	TRANSAS Europe GmbH, NAVI SAILOR 3000 ECDIS
Radar:	Litton Marine Systems BV, Type BridgeMaster E
MF/HF:	EuroCom Industries A/S, Type Sailor System 4000 MF/HF 150W
Navtex:	ICS Electronic Ltd. McMurdo ltd., Type McMurdo ICS NAV5
Inmarsat:	Thrane & Thrane A/S, Type SAILOR Inmarsat-C MES H2095C

The electronic chart system was upgraded from a Transas Navisailor type 2400 to a Transas Navisailor type 3000 on 15 August 2010. The radar equipment consisted of an S-Band and an X-Band system with ARPA and automated noise suppression. The 'Enhance' setting can be used to zoom in on targets. The manufacturer recommends this setting for the open sea. The S-Band system is advantageous in showers because the image is not grainy. The VDR recorded only the X-Band system.

VDR analysis

The VDR recorded the X-Band radar images at 15 s intervals. The settings correspond to the manufacturer's recommendations, i.e. automatic tuning, long pulse length and expanded target display for areas larger than 3 nm as well as automatic anti-clutter for rain and sea. In addition, the system was set to relative motion north up with true vectors (6 min) and true long trails (6 min), the range at 12 nm off-centre and the variable range rings at 1 nm. The red line is the displayed course line between waypoints 8 and 9. The target highlighted with a red circle by the author in Fig. 10 is Tench Island. All other targets are rain showers or, within the variable range ring, sea clutter. At 2204, the echo of Tench Island enters the 1 nm area of the range ring.

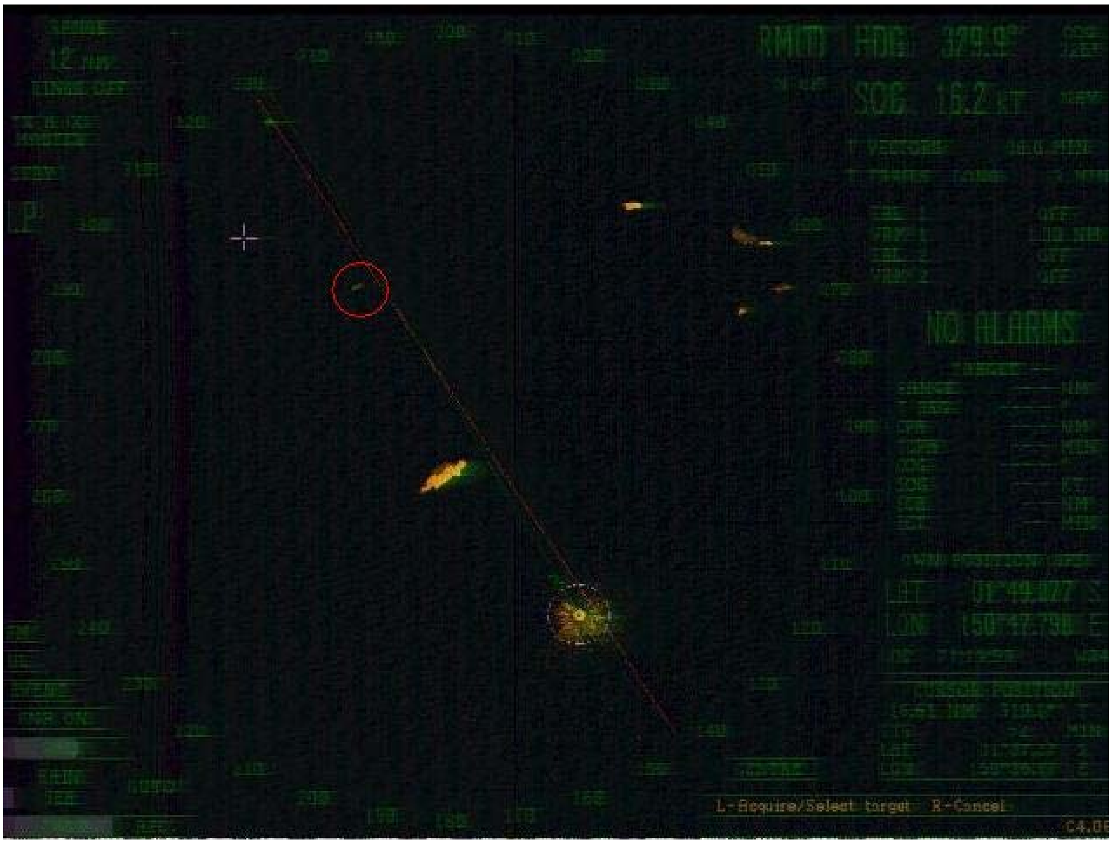

Figure 10: Radar time 211959, HDG 329.9°, COG 326°, SOG 16.2 kts

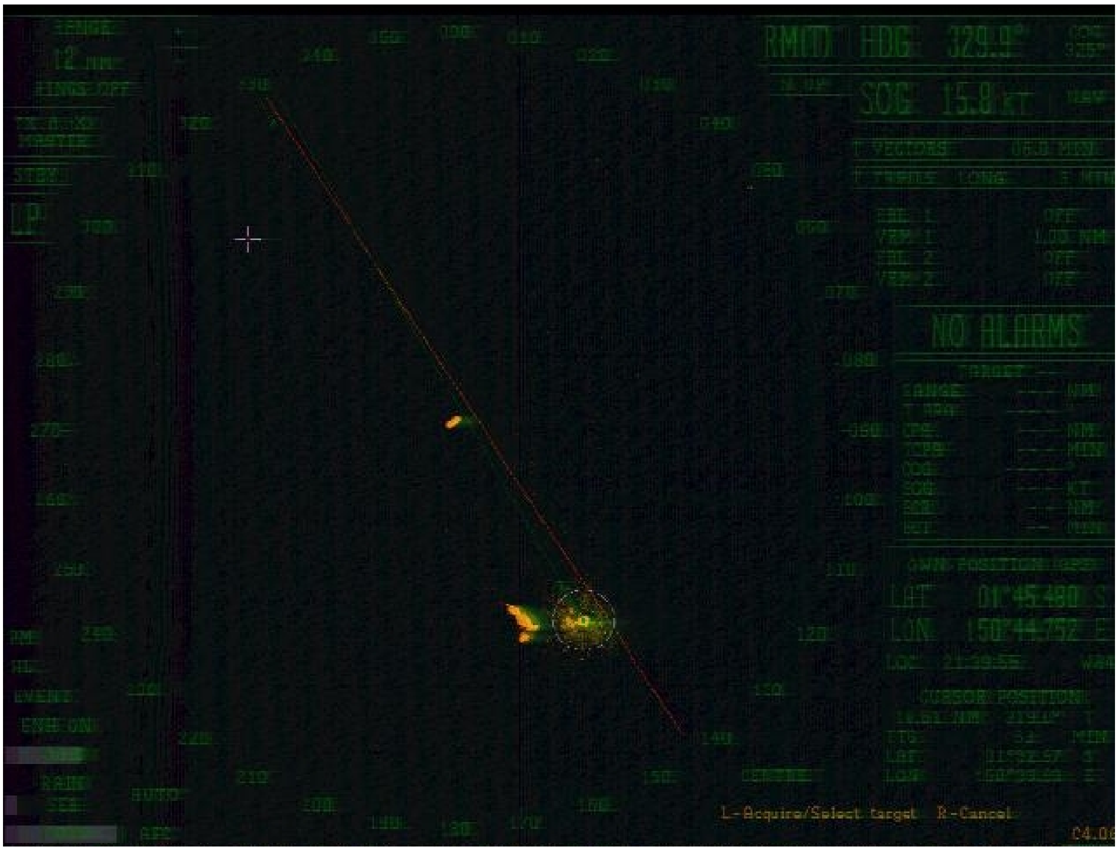

Figure 11: Radar time 213955, HDG 329.9°, COG 325°, SOG 15.8 kts

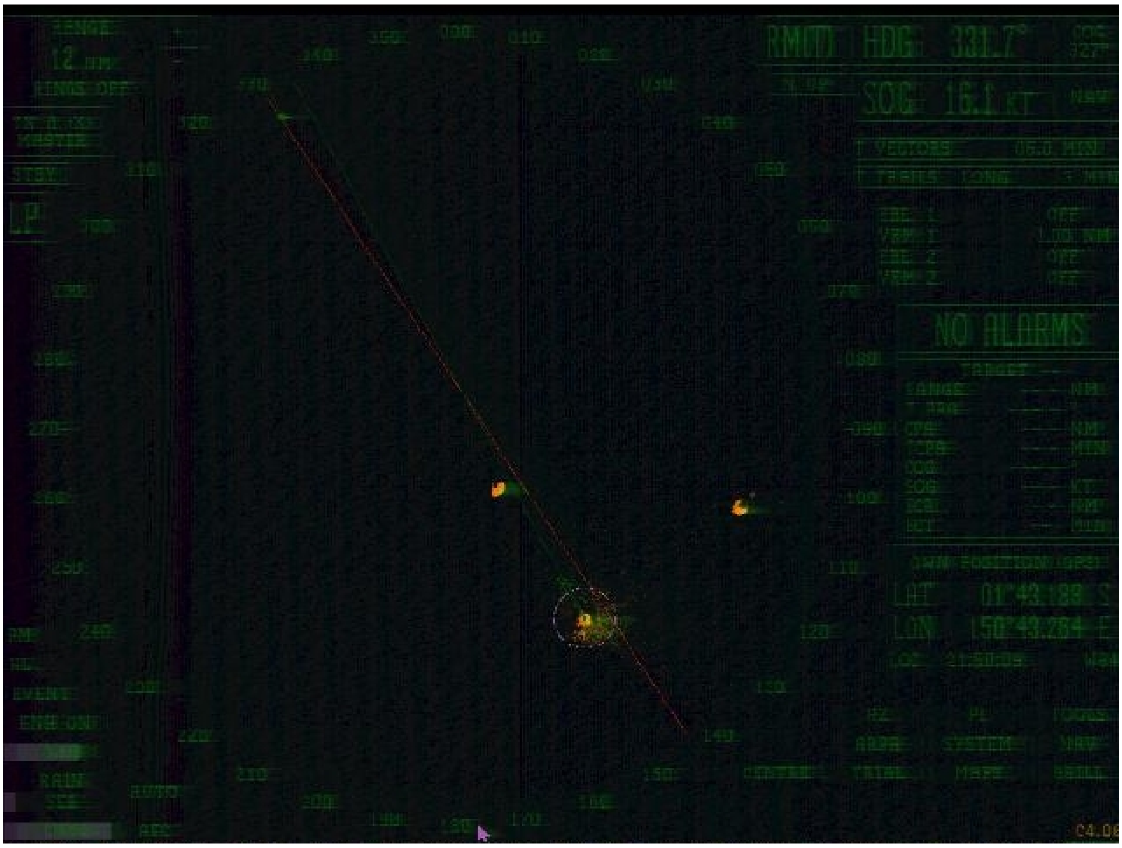

Figure 12: Radar time 215009, HDG 331.7°, COG 327°, SOG 16.1 kts

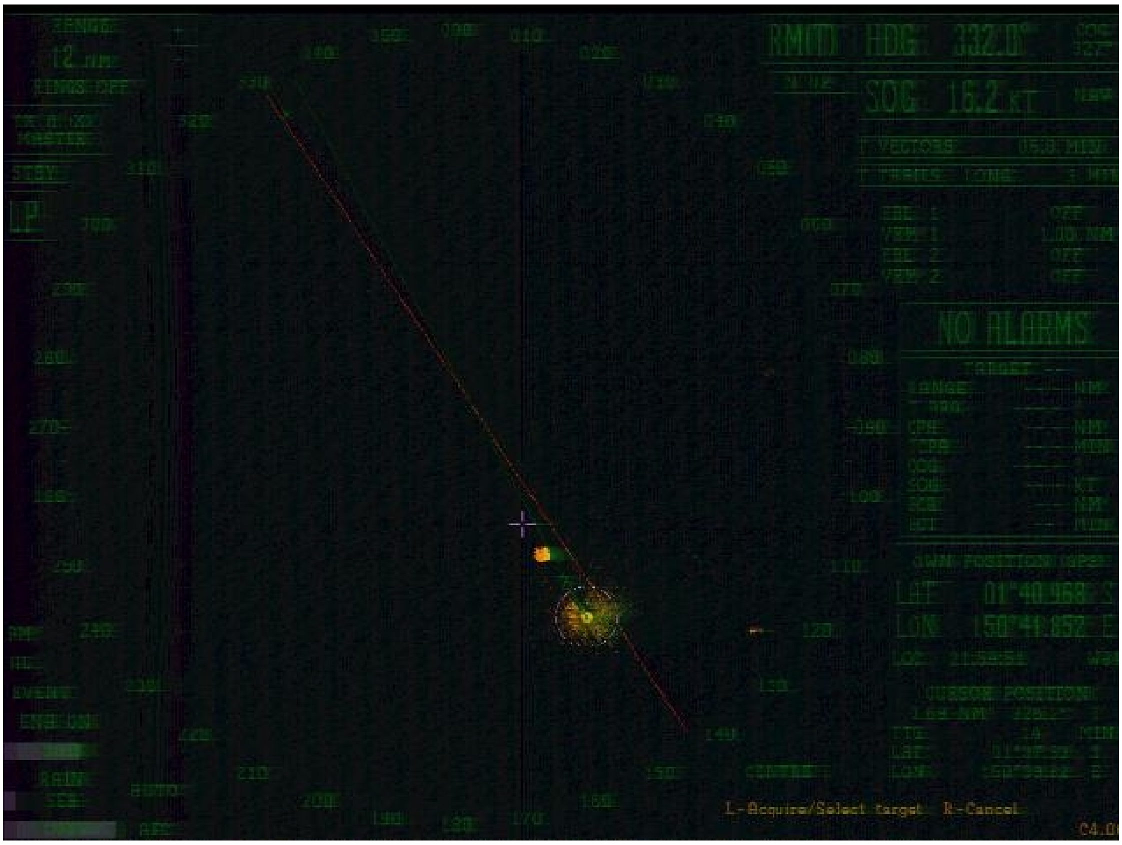

Figure 13: Radar time 215951, HDG 332.0°, COG 327°, SOG 16.2 kts

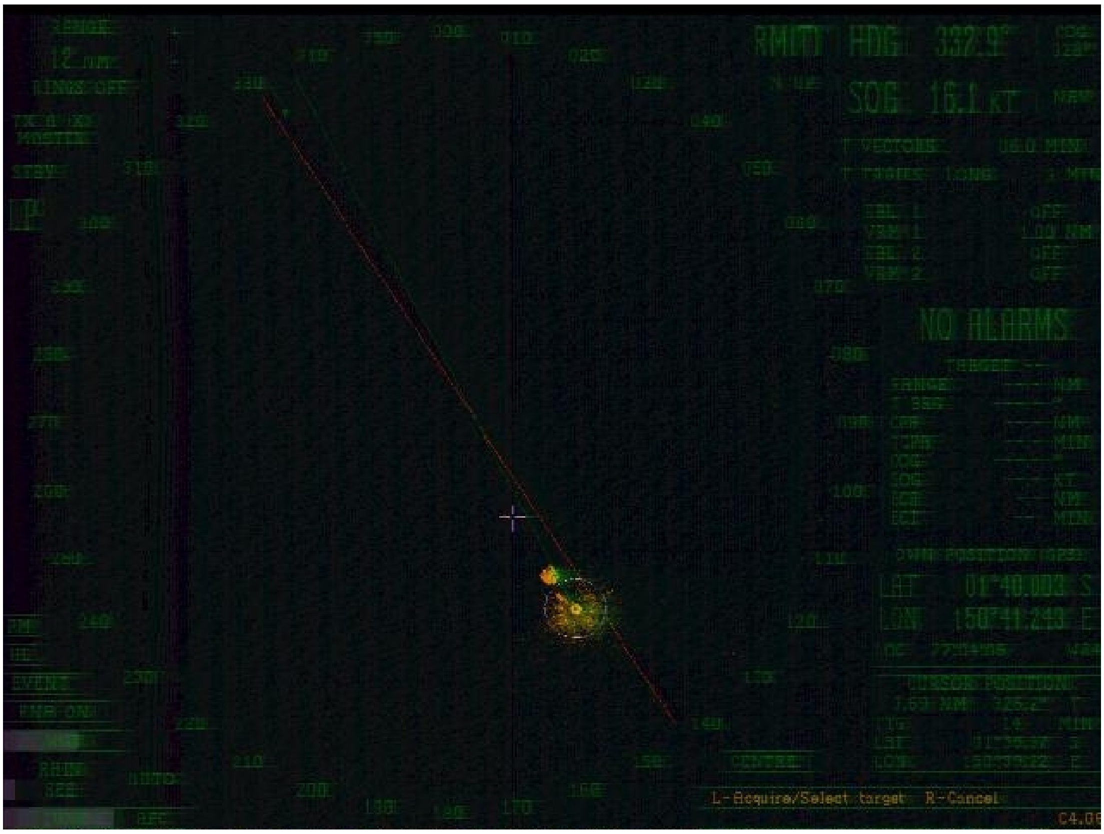

Figure 14: Radar time 220406, HDG 332.9°, COG 328°, SOG 16.1 kts

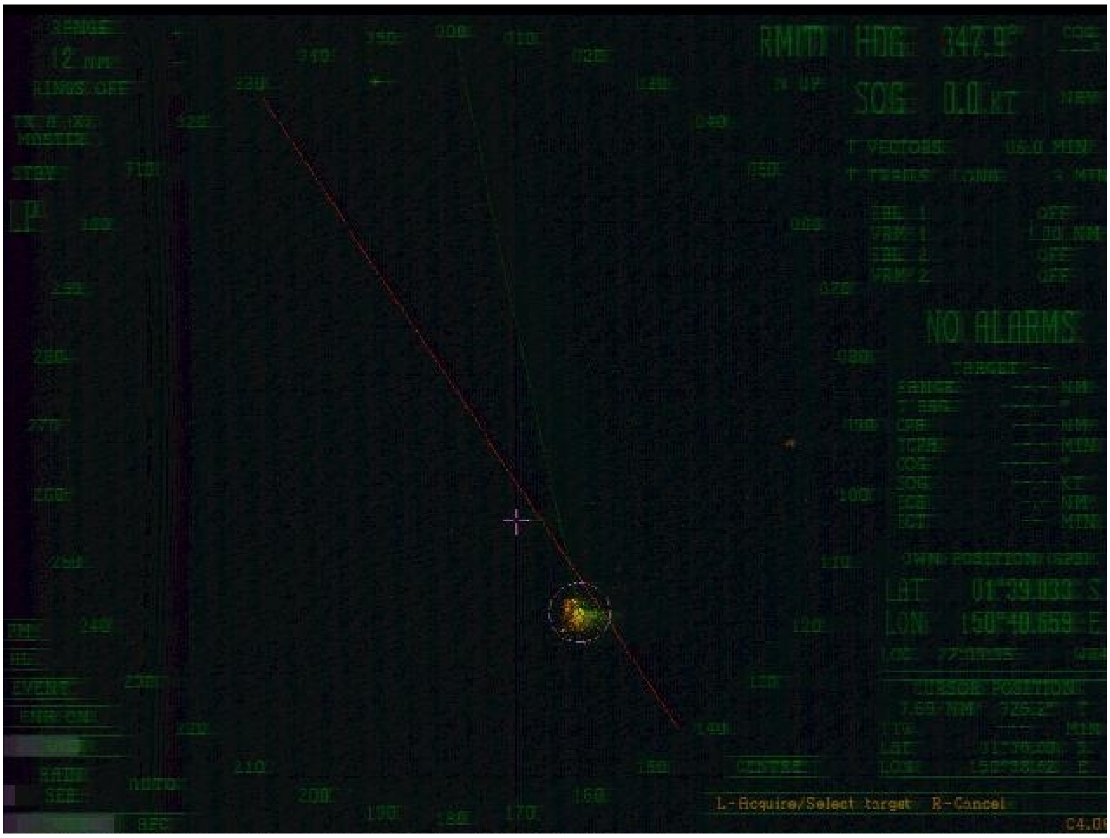

Figure 15: Radar time 220935, HDG 347.9°, COG ---°, SOG 0.0 kts

5 CONCLUSIONS

The sequence of events that led to the vessel grounding began on 1 April when the navigator learned of the new charter and pre-planned the voyage in the electronic chart system (ECS). Two weeks then passed until the voyage planning was continued on the roadstead in Vavouto between 0000 and 0600 during the anchor watch. When entering the courses in the paper chart, the course passed Tench Island by only about 1 nm to the east. It was not possible to show whether routing charts were used for the planning or whether the equatorial currents were taken into account. Weather routeing was used during the voyage.

According to the expert opinion, the grounding was the direct result of negligence by all the navigators on board, including the master. The navigator prepared the voyage plan and transferred the waypoints to the GPS receiver, the ECS and the paper chart. Here, the course line in Chart BA 4622 practically passed over Tench Island. An alarm could not be emitted by the ECS because raster data were used. The master did not carefully check the itinerary after the navigator submitted it to him before sailing from Noumea. It would have been better to plan the WP8 in such a way that the course passed centrally between Tench and Emirau islands. The course change to 327° would then have been due at 2130 and the west-setting current of 1-2 kts would not have posed a particular risk. The OOW who at 1800 changed course at waypoint 8, and his successors failed to check the new course for hazards in their navigational watch. The master relieved the OOW on the bridge on 30 April at 2100 and dealt with correspondence with the vessel operator. He, too, did not notice the island as he entered a position in the chart at 2200 prior to handing the watch back to the OOW, 10 minutes before the vessel grounded. According to the audio recordings, he only measured the latitude on the graduated scale with the compass in the assumption that he was on the course line. According to the voyage planning, the vessel was permitted to deviate by only 0.1 nm from the course line, unless giving way. Although the island and similarly shaped targets, such as rain clouds, could be seen on the radar image, it is unlikely that the master or OOW saw the island on the radar screen, because they were not aware that the island was there. They mistakenly imagined they were safe in the assumption that they were now on the long voyage to South Korea.

The examination of the vessel's track revealed a significant drift toward the island (Fig. 16) in the hour before she grounded. The ECS displayed a drift of 254° and 1.4 kts (see Fig. 5) shortly before the grounding. At the time of the grounding, the vessel steered a course of 332° (GYHDG), with a track of 322° entered in the logbook. The calculated track to the next waypoint was 327°. This is probably a transcription error in the 2000 position. This error could have influenced determination of the correction angle for compensating for the drift. Since the position at midday, the GPS positions on Chart BA 4622 were entered in the logbook every 2 hours. Chart AUS 462 was not used and it is unclear whether this was on board.

It was no longer possible to establish what alarms had been set in the GPS receiver or echo sounder. It would have been possible to generate the OFF-TRACK alarm on the GPS receiver and the depth alarm on the echo sounder. Only an unknown, periodic squeak could be heard in the audio recordings. This was an Inmarsat printer alarm, which can only be remedied by restoring the paper supply.

It is possible that both alarms were disabled or muted. With an OFF-TRACK LIMIT of 0.1 nm, it would have at least been likely that this alarm was generated too often and therefore switched off. The drift induced by the South Equatorial Current was estimated incorrectly. It is possible that the scale set on the ECS was too small and that the screen was so dim that both Tench Island and the OFF-TRACK were not clearly perceived. It is also unclear whether a lookout was posted on the bridge. The audio recordings do not reveal anything in this respect. More attention should have been paid to monitoring the radar equipment so that targets could be evaluated. There were no recordings for the S-Band system.

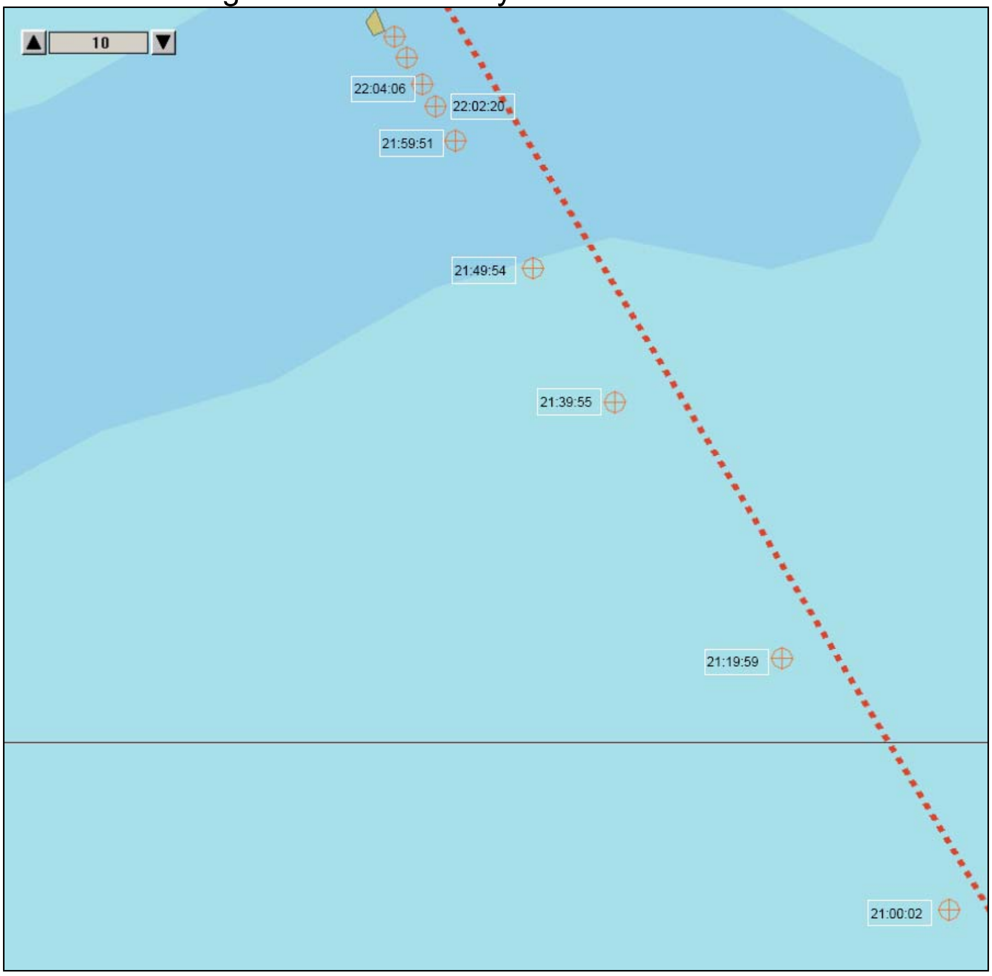

Figure 16: Source: BSH, course line and track

Although the procedural instructions in the vessel's safety management system (SMS) are extensive, cooperation between the officers of the navigational watch in terms of bridge team management (BTM), i.e. guidance, deployment and control, did not function. Team work, internal and external communication as well as the implementation of procedural instructions in voyage planning, execution and monitoring are the prerequisites for effecting maximum safety.

In this respect, individual actions and those carrying out such actions must be coordinated and monitored. Although the formal aspects of the SMS were fulfilled and the voyage planning documented, the fulfilment of basic duties with respect to the navigational watch within the meaning of STCW was lacking. The audio recordings indicate that in the case of changes of the navigational watch alone, the handing over of the watch was not performed properly, which ultimately led to the voyage planning error remaining undetected.

From a technical perspective, the navigation equipment worked. With a probability of 95%, the GPS error stood at 4-8 m (Fig. 8) and, as demonstrated by a position comparison with another vessel, there was no interference (Fig. 9). It is unclear what led to the position data (see Fig. 7) of the logbook and VDR recordings being inconsistent after the grounding. This was probably due to transcription errors or different sources (GPS receiver). The objective in the SMS of maintaining a track deviation of 0.1 nm can be critical for fully automated track control near the coastline. However, in the case of a conventional heading control with autopilot such as this, it tends to be disturbing because limits can be reached too often and lead to alarms. The X-Band radar system was set according to the manufacturer's recommendations and provided an image with showers and other targets, which was to be expected. It is possible that due to the 10 cm wavelength, the radar image of the S-Band system would not have been affected by the false echoes from rain showers. However, it remains questionable whether the relatively flat island would have been shown as clearly as on the X-Band system with 3 cm wavelength.

The vessel operator plans to equip its fleet with ENC. The so-called watchdog function may have generated an alert in the forward area and made a timely reaction by the OOW possible in terms of preventing the vessel from grounding. However, it should be pointed out that in the case of the voyage planning, the route check error would not necessarily have been detected here either, because it is dependent on the parameters set, and the course line passed the island by about 1 nm. Furthermore, the measurement uncertainty in the Pacific is noted, and in particular, the use of sea directions and routing charts for voyage planning.

Due to introduction of the ISM Code, shore and sea operation will be more transparent for all involved and compliance can be monitored easily by any interested parties. The scope comprises the international conventions and recommendations, such as SOLAS, MARPOL, COLREG, IMO, ILO and STCW. The safety management certificate confirms that the shipboard SMS corresponds to the ISM Code. It is valid for 5 years and subject to periodic inspections, which must be carried out at least once, i.e. after about 2.5 years. To ensure safe shipboard operations between vessel and shore, the company must appoint a so-called designated person ashore (DPA). Nonetheless, the SMS on board the BELUGA REVOLUTION was not practised in accordance with the ISM Code. The last two checks took place on 19 July 2009 and 17 July 2010, two and a half months after the accident.

6 SAFETY RECOMMENDATIONS

6.1 Operators and officers on watch (OOW)

The BSU recommends that the vessel owner and operator of BELUGA REVOLUTION as well as other vessel operators and vessel's commands consider that the master is responsible for planning the route and documentation and must therefore ensure that, as a key element, routing charts, are used for route planning on the oceans and are used by the OOW. They contain, amongst others, recommended shipping routes with distances, wind roses, surface currents, wave heights and frequency of gales. According to the standards regarding watchkeeping (STCW 95 Chapter VIII), the chart with the largest scale available on board must be used. The voyage plan should be on the bridge and available to the OOW at all times and the voyage continuously monitored in accordance with that. A proper handover of the watch has to be ensured.

6.2 Safety management system (SMS)

It is recommended that, in cooperation with the designated person ashore (DPA), the operator of the BELUGA REVOLUTION enforce the measures for compliance with the SMS more stringently. The shipboard route planning should be checked during the periodic and, in particular, internal ISM audits.

NB: The safety recommendations with the final investigation report could not be forwarded to the operator, since the operator has, due to reasons not associated with this accident, announced insolvency. The draft investigation report could be forwarded to all nautical officers. Only one acknowledgement of receipt is missing. They had the opportunity to comment on the report within a time limit of 60 days.

7 SOURCES

- Investigations by Australian Marine Inspections, Nautical Surveyors and Marine Consultants and BSU

- Written statements
  - Ship's command
  - Vessel operator
  - Germanischer Lloyd (GL) classification society

- Testimony of the officers on watch

- Reports/expert opinion
  - Australian Marine Inspections
  - GL
  - Transas Marine International, Sweden
  - United Kingdom Hydrographic Office, Taunton
  - Rutter Technologies, Bremen

- Nautical charts and vessel particulars as well as an analysis of the vessel's positions, Federal Maritime and Hydrographic Agency (BSH)

- BELUGA REVOLUTION's safety management system (SMS)