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

Investigation Report 455/05

Serious Marine Casualty

Grounding of CMS DORIA shortly after leaving Port Namibe (Republic of Angola) on 20 October 2005

15 January 2007

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:
Bundesstelle für Seeunfalluntersuchung
(Federal Bureau of Maritime Casualty Investigation - BSU)
Bernhard-Nocht-Str. 78
20359 Hamburg

Head: Jörg Kaufmann
Tel.: +49 40 31908300 Fax.: +49 40 31908340
posteingang-bsu@bsh.de www.bsu-bund.de

TABLE OF CONTENTS

TABLE OF FIGURES

1 Summary of the Marine Casualty

At 19:48 [1] on 20 October 2005, the full container ship DORIA sailing under German flag left the Angolan harbour of Namibe[2] heading for Cape Town. Shortly after the port pilot had left the vessel, DORIA grounded and was stuck south-west of the approach to the harbour in the area of the sandbank-like shoal of "BAIXO AMELIA" at 08:25 p.m.
No substantial damages were detected within the scope of the soundings taken immediately and of a first analysis of the damages, in particular no water ingress that would have made the continuation of the voyage impossible.
Then, in order to reduce the draught, the crew began to pump the water off the ballast tanks. Gradually some leakages in the tank system of DORIA were detected which involved a minor water ingress and the corresponding spillages of oil and harmful substances.
At about 04:00 on 21 October 2005, DORIA managed to get clear of the shoal under her own power and continued her voyage, as agreed with the vessel operator and the classification society.
During the following days on sea, soundings were taken at regular intervals, and tanks were opened as far as possible. In this connection it became obvious that the extent of the damages to the underwater hull had to be greater than initially had been assumed.
After several inquiries with various shipyards were unsuccessful, a shipyard in Durban (Republic of South Africa) could be booked for an inspection of the underwater hull and any repairs that might prove necessary.
There DORIA was docked after a previous discharge of the container cargo on November 1st, 2005. On this occasion, a not insignificant spill of heavy fuel oil and a locally restricted pollution of the environment occurred.[3]

[1] All times in this report are local times = UTC + 1 h.
[2] Sea port on the Atlantic Ocean in the southwest of Angola; previous (Portuguese) name Mossamedes.
[3] The accidental oil spill is not the subject of this investigation report, as it was associated with activities of the shipyard, i.e. it did not occur during the regular operation of a seagoing vessel in accordance with the Maritime Safety Investigation Law (SUG).

2 Scene of the Accident

Nature of the incident:	Serious marine casualty
Date/time:	20 October 2005, about 20:25
Location:	Shoal of BAIXO AMELIA; south-west of the approach to Port Namibe
Latitude/longitude:	φ 15°11.6‘S λ 012°05.6‘E

Section from the (great circle) chart 2701;
Federal Maritime and Hydrographic Agency (BSH)

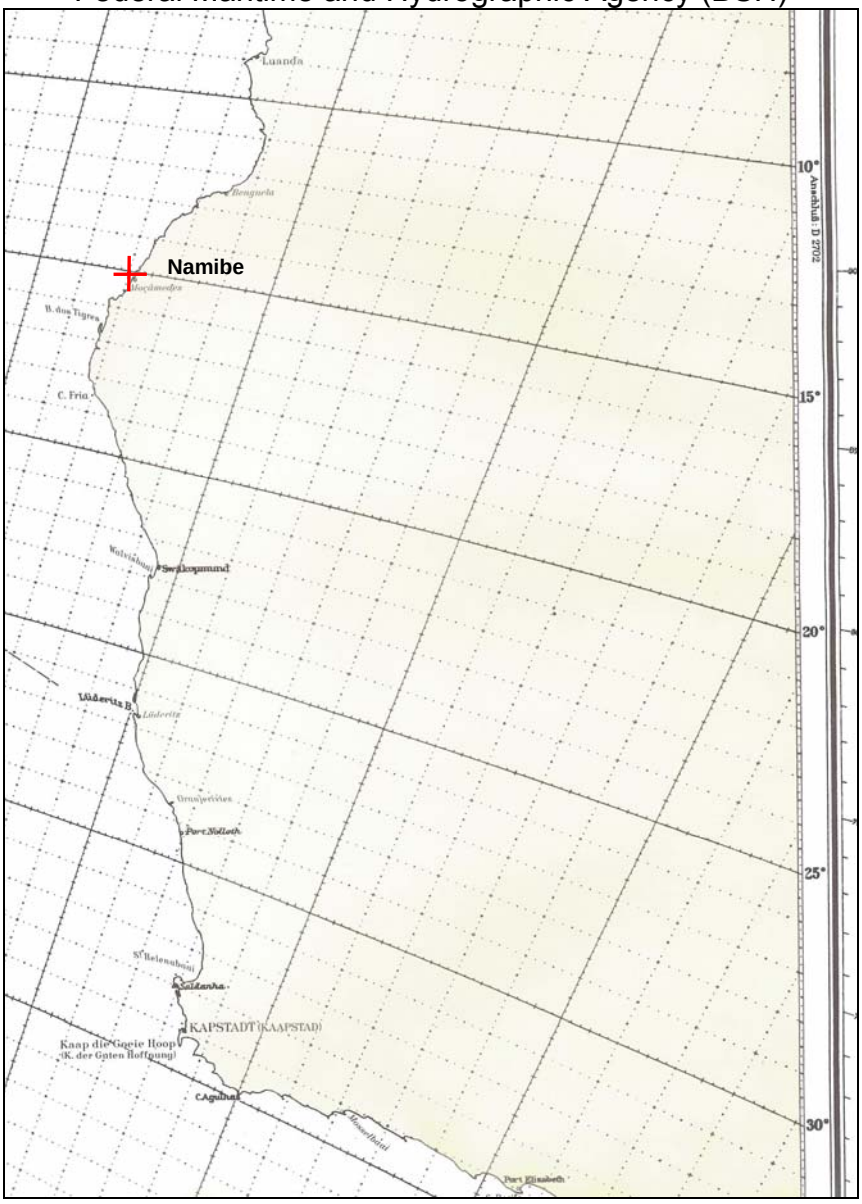

Fig. 1: Scene of the accident

3 Vessel Particulars

3.1 Photo of CMS DORIA

Fig. 2: CMS DORIA[4]

3.2 Particulars of CMS DORIA

Vessel name:	DORIA (ex. ANL PIONEER)
IMO number:	8614194
Type of vessel:	Container ship
Nationality/Flag:	Federal Republic of Germany
Port of registry:	Hamburg
Call sign:	DPGD
Vessel operator:	NSB Niederelbe Schiffahrtsgesellschaft mbH & Co. KG
Year built:	1987
Building yard:	Bremer Vulkan AG Schiffbau und Maschinenfabrik
building number:	55
Classification society:	Germanischer Lloyd
Length overall:	146.70 m
Width overall:	23.10 m
Maximum draught:	8.11 m
Gross tonnage:	10,811 gt
Deadweight:	5,214 t
Engine rating:	6360 kW
Main engine:	MAN B & W 6 L 50 MC
	Bremer Vulkan AG Schiffbau und Maschinenfabrik
Speed:	18 kn
Number of crew:	17

[4] The photograph of the vessel has been placed at our disposal by courtesy of the vessel operator.

4 Course of the accident

4.1 Preliminary remarks on the service, equipment, and manning of CMS DORIA

The vessel DORIA built by Vulkan Werft in Bremen in 1987 was in service for the Ocean Africa Container Line, a charterer residing in Durban and specialised in coastal traffic, since August 2005. The full container ship was employed in the West Coast Service between Durban and Luanda.
DORIA was equipped and manned according to the regulations. She used to pass the world-wide Port State Controls without any complaints, save some insignificant exceptions a couple of years ago.[5]
Propulsion power is provided by a right-handed fixed pitch propeller. The manoeuvring unit consists of a semi-balanced underhung rudder (maximum rudder angle 35°), an autopilot (Type C. Plath Navipilot RPI EL)[6], which was activated at the time of the accident, and a bowthruster (Type Pleuger WF160-600).
The nautical equipment of DORIA includes or included, among others, two radar units manufactured by Krupp Atlas Elektronik (Type 7600 S-Band, Type 8600 ARPA X-Band)[7], a GPS receiver (Type Trimble Nav. NT 200 DGPS), an echo sounder (Type Elac – LAZ 50/DAZ 13) and British paper charts (BA Charts). An electronic nautical chart system (ECDIS/ECS) and a vessel data recorder (VDR) were not installed.[8]
The crew consisted of 17 seamen, 4 of whom were Germans (Master, Chief Engineer, two sailors) and 11 Filipino nationals. The crew was completed by a Polish and a Bosnian crew member.

4.2 Course of the voyage up to the grounding

As no technical recordings are available for this purpose, the description of the course of the voyage of DORIA is only based upon the entries in the logbook as well as the concurring written statements by the Master (Statement of Facts) and by the 3rd Nautical Officer[9]. In addition, the Master was also questioned orally by the investigation team of the BSU.

DORIA had reached the port of Namibe in the night to October 20th, 2005, coming from Luanda, berthed at about 10:00 a.m. and left the harbour after finishing the cargo-handling operation on the same day at 07:48 p.m. bound for Cape Town. Her mean draught was 5.40 m. The vessel was commanded by the Master with the advice of the port pilot and at first steered manually by a Filipino helmsman. The port pilot left the vessel at 08:03 p.m. At about the same time the Master had informed the Chief Engineer that the voyage would begin at 08:30 p.m. At 08:08 p.m. the Filipino 3rd Nautical Officer entered the bridge. He as well had been informed about the time of the beginning of the voyage.

[5] Source: www.equasis.org.
[6] The automatic pilot was renewed after the accident during the stay in the shipyard in Durban.
[7] The radar unit was also modernized in Durban; cf. Chapter 8.
[8] An electronic nautical chart system was installed in Durban.
[9] In the following 3rd Nautical Officer or Officer in charge, respectively.

Shortly after the 3rd Nautical Officer had entered the bridge, the Master ordered the rudder 5° to port, with the intention to calmly turn the vessel to the planned south-south-western offshore course for Cape Town. As he recalls, at the time of the alteration of course, DORIA sailed on a course of 307° at a distance of 2.7 nm to the next scheduled point of alteration of course (way-point No. 3[10] of the GPS receiver). He had ordered the Officer in charge to delete this way-point (= Namibe Pilot Station) and the subsequent way-point No. 4 (= Ponta da Annunciacão). Then the 3rd Nautical Officer had informed the Master that they took a bearing of then following way-point (No. 5 = Ponta Albina) at 210°. At that time, DORIA had sailed with the rate of speed "Slow ahead" at a speed of about 5.5 kn. The Master had ordered the helmsman to first bring the vessel, which was steadily turning to port, to a course of 240°. When DORIA had reached this course, the Master had the helm switched to automatic pilot and increased the speed to "Half ahead" at 08:15 p.m.
Meanwhile the Officer in charge had prepared for taking over the watch and adjusted the setting of the port radar unit (Non-ARPA).
At about 08:20 p.m., and assuming that DORIA sailed on a safe course, the Master had informed the Officer in charge about the course of 240° to be steered and went to the radio cabin adjacent to the bridge, in order to deal with some formalities. However, he did not hand over the watch to the 3rd Nautical Officer. At that time DORIA sailed at a speed of 9.5 kn. The Officer in charge and the Filipino A.B.[11] previously assigned as helmsman and now as lookout remained on the bridge.
At 08:25 p.m., suddenly vibrations were felt on the bridge and shortly after that some heavy blows. The Master had rushed to the bridge and stopped the engine, as he became aware that DORIA obviously had grounded. His supposition was confirmed by a view on the readings of the echograph. Immediately before the occurrence of the blows, a very rapid decrease of the depth of the water was registered. He had the actual position determined by the Officer in charge. At the same time, the lookout took over the helm.
The determination of the position of the 3rd Nautical Officer had showed that DORIA had grounded on position 15°11,57'S 012°05,63'E, that is, in the area of the shoal of BAIXO AMELIA identified in the nautical chart BA Chart 1197 at a depth of the water between 2 fathoms 3 feet and 3 fathoms 5 feet[12].

The planned course and the indications for the actual course of the voyage are shown in the following **Fig. 3**.

[10] Although after an evaluation of the charts in the order of the points of alteration of course, this was the *second* way-point, the term *No. 3* is used following the diction by the Master and by the 3rd Nautical Officer. The mentioned discrepancy is of no importance for the accident.
[11] Abbreviation for able bodied seaman = function on board according to the crew list.
[12] Interpolated indication of the position of the accident following BA Chart No. 1197; fathoms/feet: English linear measures: 1 fathom = 6 feet = 1.8 metres; that is, the depth of the water around the scene of accident was between 4.5 and 7 metres, according to the chart.

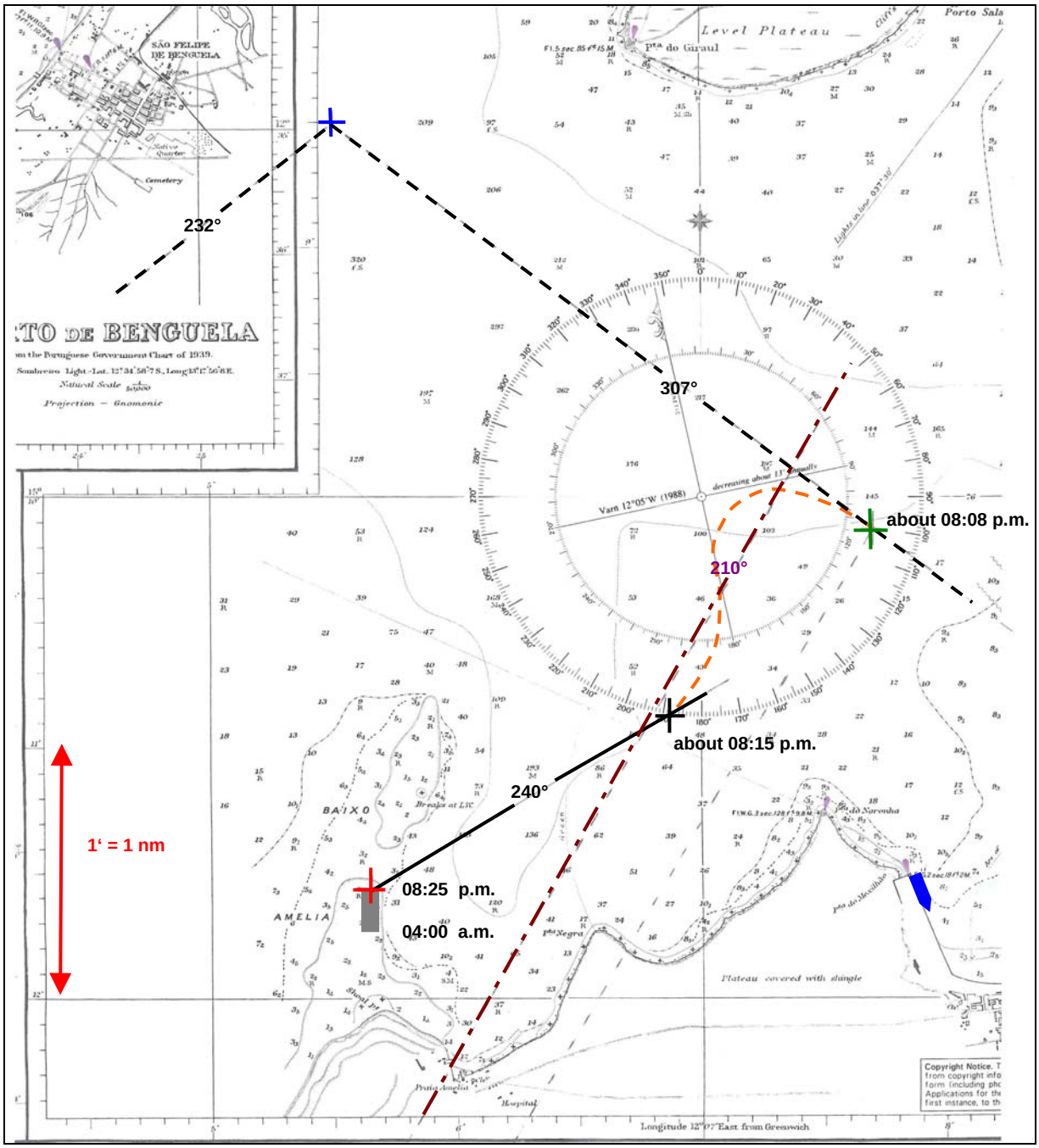

Fig. 3: Course of the voyage until the grounding (Section of BA Chart 1197)

Legend:

+	Point of alteration of course Δ K (statement by the Master)	- - - - -	Initial / planned course
+	scene of the accident	———	Course line to the accident position (retrograde dead reckoning)
+	WP 3 (deleted before it was reached)	—·—·—	Bearing of WP 5 (3rd Nautical Officer)
+	Increase of speed to half ahead (statement by the Master)	▬	DORIA at the berth (not to scale)
▮	Range of drift of the vessel	⌒	Assumed (partial) turning circle

4.3 Measures taken after the grounding until the vessel got clear

4.3.1 Assessment of the leakages

Immediately after the vessel had grounded the Master ordered soundings of the tanks and of the bilge's as well as the determination of the exact depth of the water. By this, the following information was obtained:

Time	Information
Oct. 20th	
08:45 p.m.	First sounding completed; empty tanks, bilges and other hollow spaces as well as the engine room are free from leakages except for a leak in the storage tank of the boiler feed water in the aft section of the main engine; grounding localised in the zone of frame 75
11:30	Leakage in the MDO[13] Tank No. 5 C (content of the tank at the last sounding before the accident 125.1 t); no pollution by oil observed
11:45	Leakage in the Ballast Tank No. 3 DB[14] starboard
Oct. 21st	
03:30 a.m.	(Presumed) oil spill on starboard, originating from HFO[15] Tank No. 5 on starboard (content of the tank at the last sounding before the accident 98.5 t)
04:10	No evidence of a persistence of the pollution by oil
05:25	Leakage in the Sludge Tank (multiple alarm signal "maximum level") (content of the tank at the last sounding before the accident 8.7 cubic metres)
07:30 a.m.	HFO Tank No. 5 on starboard seems to be in order; pollution by oil presumably originates from the Sludge Tank

4.3.2 Securing the vessel / return into deep water

While the damages were ascertained, at the same time a stranding of the vessel was prevented and her return into deep water at morning high water achieved in close cooperation between the bridge and the crew of the engine room.
The following table gives a survey on the course of the measures taken:

Time	Measure
Oct. 20th	
08:25 p.m. (accident)	Engine stopped; determination of the position; sounding of the tanks and bilge's ordered
08:45	Main engine and steering gear tested successfully

[13] MDO = Marine Diesel Oil = Diesel fuel (fuel used for the operation of the auxiliary generators).
[14] DB = double bottom
[15] HFO = Heavy Fuel Oil (fuel used for the operation of the main engine).

Time	Measure
09:00	Begin of the pumping out of the ballast tanks, in order to reduce the draught of the vessel
09:00	Determination of tide information (Low Water at 12:00 a.m., next High Water at 06:00 a.m.)
09:15	The vessel operator is informed by phone about the grounding and the measures initiated
10:00	Movement of DORIA towards the coast observed; in order to avoid a stranding, the main engine is started running astern, and the bowthruster operated as support
10:30	The bowthruster stops due to overload; the port anchor is let go at one chain cable length[16]
Oct. 21st	
02:15 a.m.	Main engine stopped after the vessel was repeatedly exposed to heavy shocks
04:00	DORIA gets clear and after starting the main engine reaches deep water under her own power
04:06	The vessel operator is informed by phone on the present situation
05:10 a.m.	The main engine is tested with the rate of speed “Slow ahead”; continuation of the voyage heading for Cape Town, as agreed between the Master, the Chief Engineer and the vessel operator

4.4 Continuation of the voyage to Durban

In the days following the decision to continue the voyage, great efforts were made on board in order to ascertain the extent of the damages to the underwater hull of DORIA which gradually became evident. During this work, the urgency of extensive repairs in a dock became more and more clear. While the crew on board, in close coordination with the vessel operator, succeeded in maintaining a safe operation of the vessel and at the same time preventing any pollution of the environment, the vessel operator tried to place an order with a repair yard. On the coast of Southern Africa, this raised some difficulties due to the lack of capacities there and the concerns expressed by several port authorities to give a vessel damaged on the underwater hull the permit for an entry. Finally, the Elgin Brown & Hamer Repair Yard in Durban (Republic of South Africa) was charged with the docking and repair of DORIA in their own ELDOCK floating dock.

[16] Chain cable length = section of an anchor chain = 25 metres.

The following table shows the measures taken on board up to the arrival at the port of Durban:

Date/ Time	Measure
Oct. 21st	
11:00 a.m.	Manhole covers to the Ballast Water Tanks 3 stb., centre and port are opened; in the zone of the underwater hull of Tank 3 centre serious deformations are stated, floor plates and longitudinal frames are deformed; an oil film is detected on the surface of the water in the Tanks 3 stb. and port, therefore the tanks are not emptied, so as to avoid a pollution by oil, therefore no visual inspection of the inside of the tank is possible
05:50 p.m.	Main engine stopped due to failure of the boiler
06:00	Regular soundings show water ingress into the following spaces: • Ballast Water Tanks 3 stb. and 3 port • HFO Tanks 4 stb., 4 port, 4 centre, 5 port • MDO Tank 5 centre • Cofferdam around the main engine • Boiler feed water tank • Via the outlets of the sludge tank, overflowing content of the tank is continuously running into the engine room bilge; which initially is pumped overboard after separation[17]
06:30	Salt water is discovered inside the boiler; the tank heating, with the exception of HFO Tank 5 stb., is switched off, in order to avoid any further entry of salt water into the boiler
09:25	Repair of the boiler completed
Oct. 22nd	
08:55 a.m.	Main engine started again and voyage continued; The capacity limit of the oil-water separator is achieved (5 m^3 per hour). Therefore the engine crew prepares a hose connection which allows to pump the engine room bilge water that had not been separated due to the achieving the capacity limit of the separator into the intact Ballast Water Tank 2 centre (capacity: 190 m^3). By this, a pollution of the environment can be avoided
09:30	Begin of the transfer (by pumping) and separation of the MDO/water mixture from MDO Tank 5 centre to 5 stb., in order to secure the fuel stock for the auxiliary generators
09:45	Begin of the continuous feeding of condensation water from the boiler feed water tank into the cascade tank[18], for a reduction of the salt content in the boiler feed water

[17] Separation: separation of oil, solid particles, and water by means of so-called separators functioning by centrifugal forces.
[18] Cascade tank = condensate tank

Date/ Time	Measure
Oct. 24th	
09:45	Transfer of the engine room bilge water into the Ballast Water Tank 2 centre begins; the Master states that DORIA rolls at an angle of 25°[19]
12:42 p.m.	Reduction of the rate of revolution to 105 Rpm for weather reasons
Oct. 26th	
10:00 a.m.	Oil leakages originating from the hydraulic system of the steering gear observed
Oct. 27th	
10:00 a.m.	Ballast Water Tank 1 stb. (capacity 150 m^3) is being pumped empty, in order to use this tank as well, by means of a hose connection, as storage for the engine room bilge water that had not been separated after the Ballast Water Tank 2 centre has completely been filled
02:30 p.m.	Pumping the engine room bilge water into Ballast Water Tank 1 on stb. begins
Oct. 28th	
03:00 p.m.	Ballast Water Tank 1 port (capacity 150 m^3) is being emptied, as now Ballast Water Tank 1 stb. is full as well
05:00	Pumping the engine room bilge water into Ballast Water Tank 1 port begins
Oct. 29th	
07:00 a.m.	Oil/water separator is stopped, as the vessel has reached the South African coastal waters (12 mile zone)
08:30	Passed fairway buoy of Durban Port
08:45	Begin of the drift 1 nm northeast of the fairway buoy; waiting for the pilot; continuous watch for leaking oil – no respective signs detected
09:30	Pumping the water from the engine room bilge into the Ballast Water Tank 1 port is stopped
09:56	Pilot on board
10:48 a.m.	Vessel moored at the berth in Durban

4.5 Docking DORIA

At 11:36 p.m. on October 30th, 2005, the container cargo of DORIA was completely discharged. 432 t of heavy fuel oil and 112.5 t of Diesel oil remained on board.
The events that were associated with the subsequent docking of DORIA can be learnt from the following table.[20]

[19] Rolling: swinging of a vessel around her longitudinal axis.
[20] Source: Internal investigation report by the South African Maritime Safety Authority (SAMSA) about the oil spill on DORIA in the ELDOCK floating dock in Durban; cf. also the remark in Footnote 3 above.

Date/ Time	Event
Oct. 31st	
09:00 a.m.	Slight oil leakage on stb. (shore side) observed; agent informs Port Pollution Officer
10:40	Port Pollution Officer controls the vessel and states that the pollution is minimal and has no consequences for DORIA
11:40	Pilot on board for hauling DORIA into the dock
12:00 p.m.	Vessel leaves berth
01:00	Vessel positioned inside the floating dock
01:40	Oil booms placed around the dock
01:53	Vessel on the blocks; emptying of the Ballast Water Tanks 1 stb. and port, 2 centre, 3 stb. and port contaminated with oil begins
???	In the late afternoon/evening pumping off the water around DORIA begins
Nov. 1st	
00:30 a.m.	Vessel lying dry on the blocks
06:30 a.m.	Significant spill of oil associated with lifting DORIA is noticed at daybreak; oil fighting measures are initiated and performed by the yard with the assistance of external personnel

Fig. 4: Oil catch drums beneath the hull

5 Consequences of the accident

No crew members were injured in the marine casualty of DORIA off the coast of Angola.
Due to the grounding the underwater hull of DORIA was considerably damaged. However, this did not become apparent but gradually during the continuation of her voyage by means of the results of continuous checks of the tanks. But the vessel remained fully manoeuvrable and safely reached the port of Durban. Due to the damages in the fuel tanks and bilges, harmful substances were spilled during the voyage from the scene of the accident to Durban. As the holes produced in the hull were relatively small, though, and as due to the greater density of the sea water a tendency of an entry of water into the damaged tanks could be observed rather than an oil spillage, the pollution of the environment was kept within reasonable limits until the port of Durban was reached.
After the discharge of the container cargo, a considerable fuel leakage occurred (about 80 tons) when the water was pumped off around the vessel in the dock, thus removing the external “sealing” of the tanks by the sea water now absent.

5.1 Damages of CMS DORIA

The underwater hull of DORIA was exposed to a grounding in the area of the frames 13 to 136. In detail, the following spaces were damaged:

- Ballast Water Tanks No. 3 stb. and port
- Ballast Water Tank No. 3 centre: feeding pipe broken
- Heeling Tanks[21] No. 2 stb. and side
- Ballast Water Tank No. 4 centre
- Bilge of cargo hold 2 stb.
- HFO Tank No. 5 stb.
- MDO Tank No. 5 centre
- Boiler feed water tank
- Cofferdam

The grounding also affected the rudder blade (**cf. Fig. 6**), however, without any failure of the steering gear.

[21] Heeling tanks are filled with sea water; they serve for the compensation of heelings in particular during lading and discharging.

Fig. 5: Damages to the underwater hull[22]

Fig. 6: Deformations on the rudder blade[23]

[22] Photograph by courtesy of the vessel operator.
[23] Photograph by courtesy of the vessel operator.

5.2 Pollution of the environment

With regard to the pollution caused to the environment, a distinction must be made between the spillages of harmful substances after the grounding and those during docking in. As already explained above, the pollution of the environment after the grounding was relatively small, as on the one hand, no very great amounts of oil got lost, and on the other hand, the spillage of harmful substances that nevertheless was observed and unavoidable after the accident extended over a longer period. Thus, no considerable local pollution of the environment occurred.

On the other hand, the pollution by oil that occurred in the ELDOCK floating dock in Durban was not insignificant, with an estimated spilled amount of about 80 tons. Nevertheless, serious and permanent damages to the environment could be prevented.

This success was mainly due to the following factors:

- Favourable weather
- Use of oil booms that had already been placed around the dock
- Immediate initiation of cleaning measures, with the participation of personnel of the shipyard and with the support of other companies

Fig. 7: Pollution by oil in ELDOCK

6 Investigation of the accident

6.1 Preliminary remarks

As already indicated above[24], the investigation of the accident of the BSU is limited to the causes and promoting factors of the grounding of DORIA off the coast of Angola. Whereas any possible mistakes and omissions during docking the vessel in Durban that resulted in the pollution of the environment that occurred there, are not a subject of this investigation report, because that event is neither formally nor really an incident that was associated with the operation of a seagoing vessel in maritime traffic.

The clarification of the causes that resulted in the grounding of DORIA was performed based upon the largely identical, plausible and therefore credible statements that the investigation team of the Federal Bureau of Maritime Casualty Investigation obtained from the Master of the vessel and from the 3rd Officer in charge who was on the bridge at the time of the accident. In addition, the course of the voyage of DORIA before the grounding could be reconstructed at least roughly, based upon the submitted charts with the entries indicated in them.
The extensive e-mail/fax correspondence with the vessel's command, but also with the charterer, different agencies, and the insurer made available by the vessel operator made it possible to reconstruct the measures taken on board aiming at minimising the consequences of the accident during the voyage to Durban. In this respect the crew acted in an ideal manner, taking into consideration the circumstances. In particular DORIA was safely navigated to Durban and the spillages of harmful substances could be kept within reasonable limits. Therefore a more intense investigation of these events following the marine casualty was unnecessary.

In the following, the course of the voyage of DORIA up to her grounding shall be reconstructed (6.2). Then the results of the investigation of the nautical charts made available will be presented (6.3). In the end, some statements will follow on the other concomitant circumstances and factors (6.4) that are also of importance for the analysis of the marine casualty following in Chapter 7.

6.2 Reconstruction of the course of the voyage up to the grounding

With respect to the reconstruction of the course of the voyage of DORIA, due to the lack of relevant technical records, the BSU was only dependant on the concurrent written statements by the Master (Statement of Facts) and by the 3rd Nautical Officer and the entries in the logbook as well as in the used charts (BA Charts No. 1197 and No. 627). In addition, the Master was questioned by the investigation team of the BSU.

[24] Cf. Footnote 3.

The DORIA had left the berth of Port Namibe at 07:48 p.m. on October 20th, 2005. The front draught was 4.50 m and the aft draught was 6.20 m. The vessel was operated by the Master with the advice of the port pilot and at first steered manually by a Filipino helmsman. The port pilot left the vessel at 08:03 p.m.

For the navigation when leaving the harbour, the Master at first used the large-scale harbour and approach plan "BAIA DE MOSSAMEDES" included in the BA Chart No. 1197 "PLANS ON THE WEST COAST OF AFRICA". About 15 minutes before the accident, he changed over to the small-scale BA Chart No. 627 "LUANDA TO BAIA DOS TIGRES".

From the original plan of the harbour used on board, which was submitted to the Federal Bureau of Maritime Casualty Investigation, various course lines could be taken, partly together with the indications of the course, apart from the entered position of the accident and the subsequent drift positions of DORIA. In addition, two way-points were shown that had been entered into in the chart in connection with the planning of the voyage, that is, before the accident. The first way-point was in the immediate proximity of the berth of DORIA and obviously represented the presumed nautical starting point of the voyage. The second way-point (cf. below in **Fig. 8** way-point 3[25]) was at the outermost left (= western) edge of the plan and labelled with the inscriptions A/C[26] and P/S[27]. Starting from this way-point, a course line was entered into the plan, together with the indication of the course of 232°. However, as way-point 3 was in the immediate proximity of the limits of the relevant harbour and approach plan, the mentioned course line of 232° had been drawn beyond the limits of that plan and extended over the approach and harbour plan of PORTO DE BENGUELA, which is also included in BA Chart No. 1197. Below the mentioned course line there was an indication "**x 15'** ", by which it was made clear that the next point of alteration of course (way-point No. 4) was at a distance of 15 nm
The planning of the route, which had been performed by the 3rd Nautical Officer and controlled by the Master before the start of the voyage, was continued in the BA Chart No. 627 with the carry-over of the course line of 232° and the following other courses heading for Cape Town.

With the intention to more quickly pass the shoal of BAIXO AMELIA, which originally should be circumnavigated at a distance of 2.3 nm between its northern cape and way-point No. 3, the Master decided to skip this point and ordered the rudder 5° to port. He assumed that DORIA would describe a spacious turning circle with the current rate of speed "Slow Ahead" and subsequently pass the shoal presumably located port ahead at a sufficient distance.

[25] Cf. above the remark in Footnote 10.
[26] A/C = Alteration Course = alteration of course.
[27] P/S = Pilot Station (pilot station).

The time and the exact position at which the mentioned steering order was given have neither been entered into the chart nor recorded in writing elsewhere. However, it was possible to approximately determine the position of the point of alteration of course in question as well as the position of DORIA when reaching the course on which she headed for the shoal (final point of the (partial) turning circle).

- The approximate position of alteration of course (φ 15°10.1‘S λ 012°07.7‘E; cf. **Fig. 8** „Δ K (as stated by the Master)“) results from the following consideration:
  At the time of the alteration of course, which is stated to have taken place shortly after the 3rd Nautical Officer had entered the bridge, that is, towards 08:08 p.m., as the Master recalls, DORIA was on a course of 307° at a distance of 2.7 nm to way-point No. 3 (φ 15°08.5‘S λ 012°05.5‘E).
  When the Officer in charge had carried out the order by the Master to delete way-point No. 3 (= Namibe Pilot Station), which in his opinion was superfluous, and also to delete the subsequent way-point No. 4 (= Ponta da Annunciacão; φ 15°17.7‘S λ 011°53.25‘E), he reported to the Master that the bearing to the now following way-point (No. 5 = Ponta Albina; φ 16°S λ 011°37.3‘E) was 210°.
  A comparison of the (fictive) bearing of way-point No. 5 at the time DORIA was on the position where she altered her course, as told by the Master, and the bearing determined by the Officer in charge results in a difference of 0.5°, so that one may proceed on the assumption that the turning circle of DORIA must have been approximately within the sector shown in Fig. 9.
- The final point of the (partial) turning circle (**cf. Fig. 8**) could approximately be determined by means of retrograde dead reckoning starting from the position of the accident:
  The Master and the Officer in charge have congruently reported that DORIA headed for the position of the accident at a course of 240°. In addition, the correctness of the statement is assumed that the rate of speed of DORIA was increased to “Half ahead” when she reached this course at about 08:15 p.m. This results in the fact that up to the time of the accident, which was 10 minutes later, the vessel sailed at an approximate average speed of about 8.2 kn[28], thus covered a distance of about 1.4 nm on the course line of 240°.

After reaching the new course and increasing the rate of speed to “Half ahead” no determination of the position was carried out. Therefore the bridge team did not realise that the course line was shifted by at least 0.6 nm to the south from the course line that – provided the depth of the water is stated correctly in the BA Chart No. 1197 – would have allowed a safe passage of the shoal of BAIXO AMELIA.
Inevitably, DORIA grounded less than 0.5 nm off the coast at 08:25 p.m.

[28] A relatively speedy increase of the speed from “Slow ahead” (about 6.8 kn) to “Half ahead” (about 9,5 kn) is assumed.

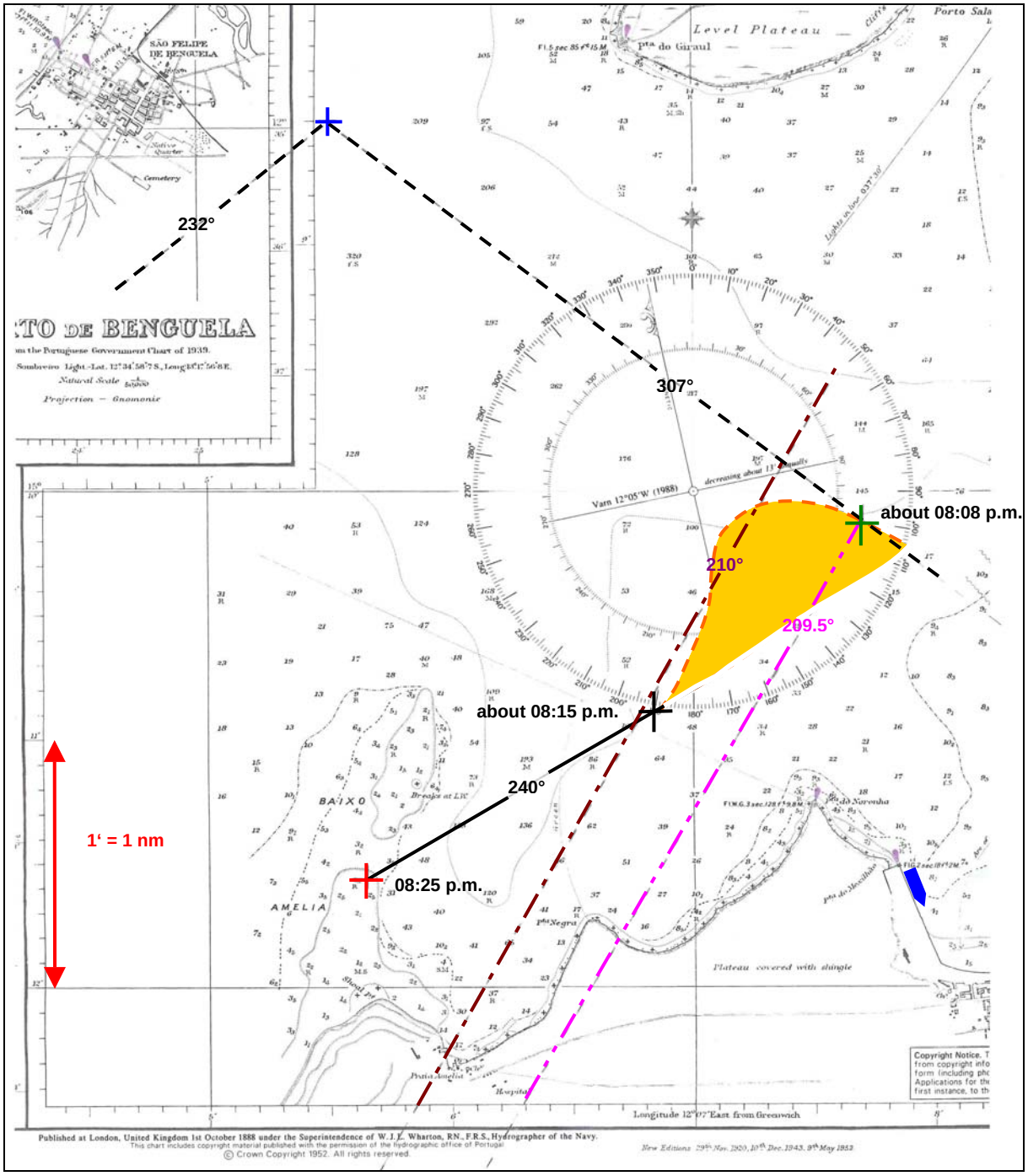

Fig. 8: Reconstruction of the beginning of the accident (Detail BA Chart 1197)

Legend:

+	Point of alteration of course Δ K (statement by the Master)	- - - - -	Initial or planned course, respectively
+	Position of the accident	———	Course line to the accident position (retrograde dead reckoning)
+	WP 3 (deleted before it was reached)	- · - · -	(Fictive) bearing WP 5 at Δ K
+	Final point of the (partial)turning circle	— · — · —	Bearing of WP 5 (3rd Nautical Officer)
▬	DORIA at the berth (not to scale)		Sector of the (partial)turning circle

6.3 Background information on the used charts

The BA Charts No. 1197 and 627 are the only charts that are available for the approach to the harbour of Namibe.

6.3.1 BA Chart No. 1197

The chart No. 1197 (PLANS ON THE WEST COAST OF AFRICA) with the outside dimensions [29] 71 cm x 52 cm includes the three harbour and approach plans

- BAIA DE MOSSAMEDES (= Namibe); scale 1:25,000
- PORTO DE BENGUELA; scale 1:50,000
- BAIA DOS ELEFANTES; scale 1:25,000

The plans are based on data from nautical charts issued by the Portuguese Colonial Government dating back to the years 1938 to 1940, which by courtesy of the Hydrographic Office of Portugal 1952 were issued by the UK Hydrographic Office as New Edition of the BA Chart 1197. In the years 1960, 1964, 1965, 1970, 1972, 1974, 1998, 1999 and 2004 minor corrections were performed[30].
According to British tradition, the depths of the water are stated in fathoms and for depths of less than 11 fathoms in fathoms and feet.[31]

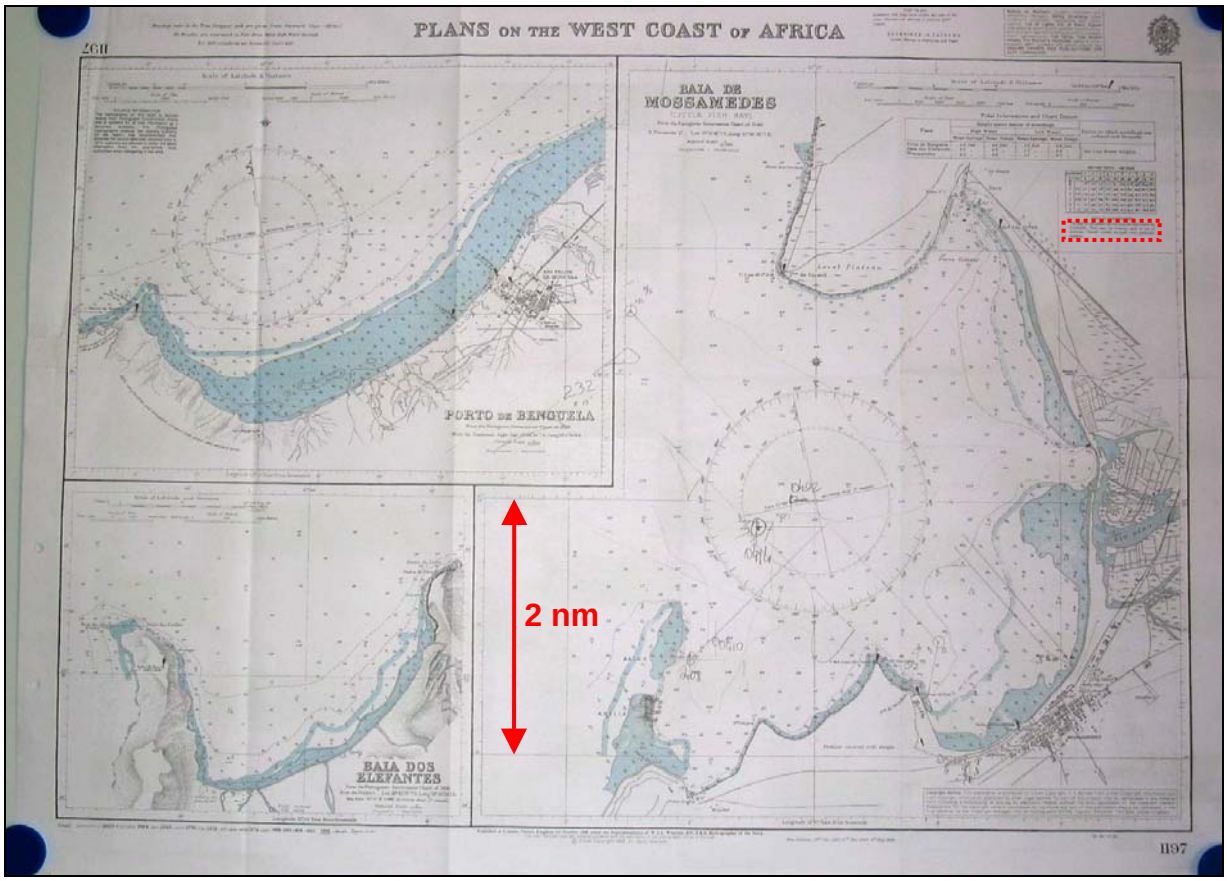

Fig. 9: Photograph of BA Chart No. 1197[32]

[29] Width x height.
[30] So-called “Small corrections”.
[31] Cf. above Footnote 12.
[32] Copy used on board.

In the right upper corner of the plan (cf. red marking in **Fig. 9**), a remark is printed that the statements on the sea marks are unreliable. They could be lost or unlighted or lying on other positions. Accordingly, the vessels are urged to navigate with particular caution.

6.3.2 BA Chart No. 627

The chart No. 627 (LUANDA TO BAIA DOS TIGRES) has the outside dimensions 71 cm x 104 cm. It covers the area of the West Coast of Africa between the southern latitudes of 8°10‘ and 17° in the scale 1:1,000,000, thus, from north to south it spans over a distance of 8°50‘ = 981.6 kilometres.
This edition of the British nautical charts of 1986 also originates from the charts of 1975 issued by the Portuguese Colonial Government. The chart 627 was endorsed “Small corrections” in the years 1987, 1990 and 1992.

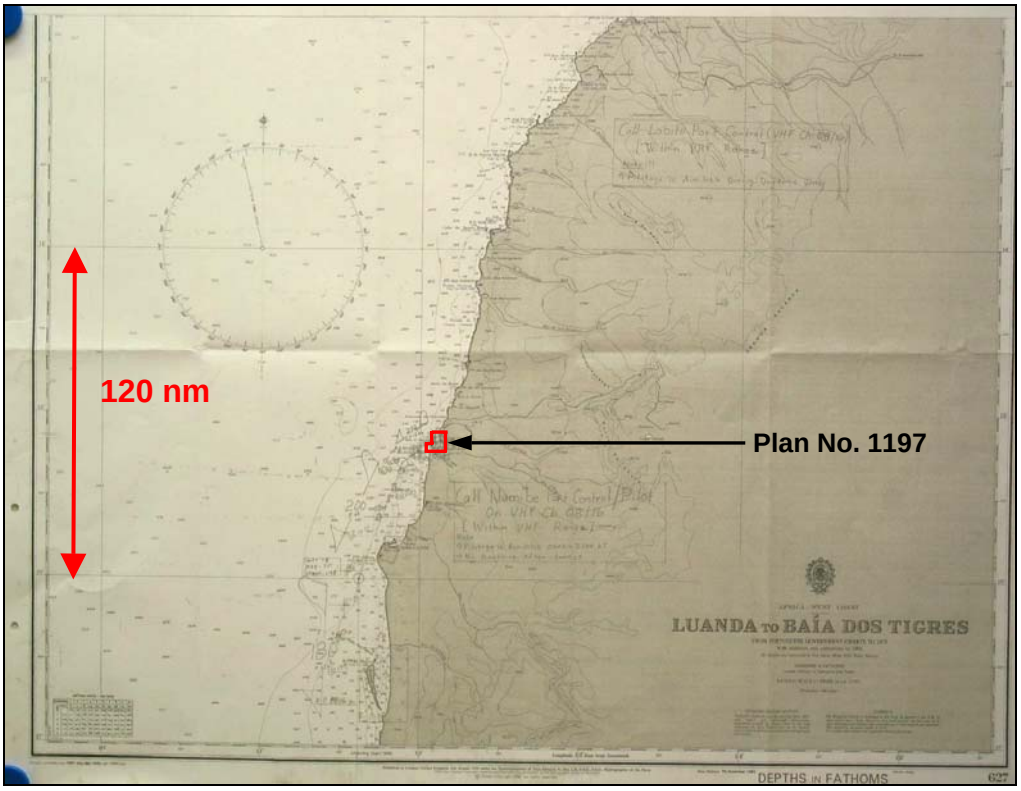

Fig. 10: Photograph of BA Chart No. 627[33]

6.3.3 Comparison of both charts

A comparison of **Fig. 9 and Fig. 10** illustrates the effects of the different scales of the Harbour and Approach Plan No. 1197 (1:25,000) and of the General Course Map No. 627 (1:1,000,000) on the representation of the navigation zone. It can clearly be seen that Chart No. 627 is completely unsuitable for the navigation close by the shore and in particular for approaching the port. **Fig. 11** below shows the relevant section of the chart in full-scale as an illustration of this fact.

[33] Copy used on board, only the lower of two halves of the chart of the same size is shown.

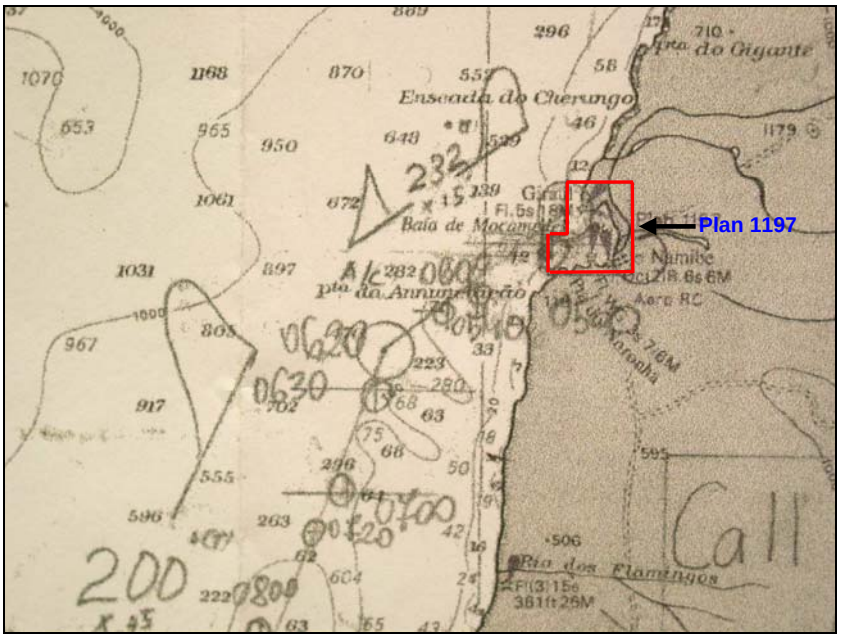

Fig. 11: Section of BA Chart No. 627[34]

In addition, the following table elucidates, by means of numerical examples, which is the influence of the scale on the work with the respective nautical chart.

	1 cm =	1 nm =	Duration of a passage (at v = 9.5 kn)	
			of a 1 cm long section of the chart	of the whole chart from North to South
Chart 627	5.42 nm	0.185 cm	about 34 min	about 55 h 47 min
CHART 1197 (Plan Namibe)	0.163 nm	7.35 cm	about 1 min	about 37 min

6.4 Investigation of other concomitant circumstances

6.4.1 Scene of the accident (depth of the water)

The shoal of BAIXO AMELIA extends over a distance of about 1.3 nm to the north at a distance of about 2 nm west of the harbour exit of Namibe, starting from the shore line. The width of the sandbank (extent from east to west) is about 0.6 nm in the direct proximity of the shore and decreases to about 0.2 nm towards the north side.
The depth of the water varies in a range between about 1 fathom 2 feet and about 7 fathoms.[35] The prevailing depth of the water is around 2 fathoms.[36]

[34] Copy used on board; presentation in the original size.
[35] = 2.4 m to 12.8 m.
[36] = 3.6 m.

It must be considered that the aforementioned details are information from an obsolete chart. However, shifting movements of the sandbank are possible and caused the International Hydrographic Organization (IHO) to recommend a repeated survey of the sandbank.[37]

6.4.2 Weather on the day of the accident

The Federal Bureau of Maritime Casualty Investigation (BSU) commissioned Germany's National Meteorological Service – Department Marine Meteorological Services – to furnish an expert opinion on the weather and seaway conditions on the day of the accident in the area of the South Angolan Atlantic Coast. This shows that the weather in the relevant coastal area was determined by a vast anticyclone. The weather was bright and dry. The horizontal visibility during the day was clearly above 10 nm, in the night, it was around 5 nm
In the afternoon and evening of the October 20th, 2005, with temperatures of about 25° C near the shore a weak westerly wind was blowing that reached an average force of 2 to 3 Bft. The wind was coming from the open sea from the southeast and had a force of 5 Bft.
From the winds described and a swell coming from the southern direction, a possible total seaway in the area of the accident results with a significant wave height of about 3 metres.

6.4.3 Nautical experience of the bridge crew

6.4.3.1 Master

The German Master, 41 years old at the time of the accident, had been at sea since 1986 and obtained his licence as officer in charge of the watch for ocean-going vessels in 1992. This licence was upgraded to a Master's licence 1994. In 1999 he took over his first command as a Master and subsequently commanded container ships. On August 16th, 2005, he took over the command of DORIA.
This was the first time he called at the port of Namibe.

6.4.3.2 3. Nautical Officer

The 28 year old Filipino Officer in charge of the watch has been holding the licence for an Officer in charge of the watch since 2001 and at first sailed as 4th Officer. Since 2003 he has been sailing as 3rd Nautical Officer on ocean-going container vessels. He as well had never been to Namibe before.

6.4.4 Working hours and rest periods

According to the German Seafarer's Law the Master does not belong to the crew members. Thus the provisions on the working hours of § 84a ff. of the German Seafarers' Law (SeemG) would only apply to him in accordance with § 104 SeemG, if he had worked as Officer in charge. However, this is not the case.
But even if the Master is included into the scope of application of the provisions on the maximum working hours and minimum rest periods, an examination of the records of his working hours and rest periods for October 2005 shows that the provisions on the maximum working hours (14 hours in each 24 hour period; 72 hours

[37] To this also cf. the explanations below under No. 7.3.2.

within each 7 day period) and the minimum rest periods (10 hours in each 24 hour period; 77 hours in 7 days) from art. 84a Seafarers' Law have been observed, apart from two insignificant deviations.

On the other hand, the evaluation of the time sheets of the 3rd Nautical Officer for the month of October 2005 shows that he regularly exceeded the admissible limit for the maximum working hours within each 7 day period (cf. the following table; violations of the limits are marked in red).

Date	Rest (h)		Work (h)		Rest (h)		Work (h)	
	from 0:00 a.m. to 12:00 a.m.				within the previous 7 days			
	Master	3rd Nautical Officer	Master	3rd Nautical Officer	Master	3rd Nautical Officer	Master	3rd Nautical Officer
01.10.	16	12	8	12				
02.10.	12,5	13	11,5	11				
03.10.	12	15.5	12	8,5				
04.10.	13	11	11	13				
05.10.	11	13	13	11				
06.10.	15	12	9	12				
07.10.	16	12	8	12	95,5	88,5	*72,5*	79,5
08.10.	16	15,5	8	8,5	95,5	92	*72,5*	76
09.10.	14	12,5	10	11,5	97	91,5	71	76,5
10.10.	15	11,5	9	12,5	100	87,5	68	80,5
11.10.	16	13,5	8	10,5	103	90	65	78
12.10.	12,5	13,5	11,5	10,5	104,5	90,5	63,5	77,5
13.10.	16	10	8	14	105,5	88,5	62,5	79,5
14.10.	16	12	8	12	105,5	88,5	62,5	79,5
15.10.	16	12	8	12	105,5	85	62,5	83
16.10.	15	11,5	9	12,5	106,5	84	61,5	84
17.10.	14	13	10	11	105,5	85,5	62,5	82,5
18.10.	14,5	12,5	9,5	11,5	104	84,5	64	83,5
19.10.	15	12	9	12	106,5	83	61,5	85
20.10. (accident)	12	10,5	12	13,5	102,5	83,5	65,5	84,5

§ 89a para 1a SeemG in conjunction with art. 9 para 6 MTV-See[38] allows that vessels during a rapid succession of several ports may deviate from the above mentioned maximum working hours. But after the vessel has left the respective area of the voyage, the Master has to ensure that all crew members that worked beyond the normal maximum working hours are immediately granted additional rest periods amounting to the number of hours they worked beyond the limit. An observation of this provision does not result from the proof of working hours for the 3rd Nautical Officer.

[38] General wage agreement for the German merchant shipping dated March 11th, 2006, last revised by the wage agreement dated August 24th, 2005 (The vessel operator of DORIA is a member of the Wage agreement.).

7 Analysis

The grounding of DORIA is mainly due to navigational omissions (7.1). These were considerably promoted by the insufficient cover of the relevant coastal strip by nautical charts (7.2). Compared to this, the other general conditions (weather, qualification, working hours) had no significant influence on the development of the accident (7.3). The measures taken by the crew after the accident, after the damages to the underwater hull had become obvious, aimed at keeping the pollution of the environment caused by DORIA within reasonable limits and at safely taking the vessel to a repair yard; both succeeded (7.4). During docking in, a considerable leak of harmful substances occurred. The circumstances of this incident were not examined by the BSU, as this was not a marine casualty according to the provisions of the Maritime Safety Investigation Law.

7.1 Navigational omissions

7.1.1 Determination of the position

The marine casualty is mainly due to the fact that no clear determination of the position was performed for a period of almost 20 minutes (!) and thus by far too long for a voyage in the area.

Before starting the port steering manoeuvre with the intention to turn to an intermediate course of 240° (that is, about 08:08 p.m., according to the results of the investigation) the Master had, by bearings and the distance to the way-point 3, a point of reference of the Position of DORIA at the time he started the turning. However, the corresponding position was not entered into the chart No. 1197. Instead the Master changed the nautical chart even before they reached the course of 240° – most probably in order to obtain a survey on the further course of the voyage and the positions of the pending points of alteration of course. It was almost inevitable that the shoal of BAIXO AMELIA in the immediate proximity of the new course got out of the navigator's sight. While it was absolutely impossible to overlook this shoal on the large-scale Approach Chart No. 1197, due to its extent over an area of about 1.3 nm (= 9 cm in the chart) and the clear emphasise by means of colours, on the small-scale chart No. 627 this was very easily possible. Due to the scale, the shoal was printed there in a form reduced to the standard symbol (a cross that is surrounded by a dotted circle; diameter of the circle about 3.5 mm).

Even after the new course (240°) was reached, neither a determination of the position was made nor an entry into the harbour and approach chart which in this respect was the only suitable chart.

7.1.2 Bridge Team

The 3rd Nautical Officer, who entered the bridge towards 08:08 p.m. and prepared himself for taking over the watch which was due for about 08:30 p.m., also failed to determine the position of DORIA before, during or after reaching the new course at the latest (about 08:15 p.m.). Instead the assistance he provided to the Master in his command was restricted to the deletion of two way-points from the GPS route memory, as ordered, and to the determination of the bearing to the now following way-point (= 210°). About his other activities on the bridge up to the accident it is only

known that he had adjusted the radar unit to be used by him in the oncoming watch and, as for the rest, his eyes had to adapt to the darkness on the bridge.

This information illustrates a great lack of co-operation (teamwork) on the bridge which promoted the accident to a considerable extent. Even if the Master had not yet officially handed over the watch to the designated officer in charge of the watch it complies with good seamanship that the officer obtains a view of the nautical and navigational particularities, in particular the position and the course of the vessel (and of other traffic, if necessary) on his own initiative and without express instruction as soon as possible after entering the bridge. To begin with, this applies independent of whether the Master is actively busy influencing the track of the vessel or whether he is obviously behaving in a more passive manner. In both cases, a nautical officer present on the bridge who is going to take over the watch, is obliged to acquaint himself with the prevailing situation. But at the latest at the time at which the Master leaves the bridge, as in this case, and even merely heading for the adjacent radio cabin, a nautical officer remaining alone on the bridge is obliged to assume the responsibility for the safe navigation of the vessel. The lack of a formal handover of the command does not change anything of this duty whatsoever.
The statement of the 3rd Nautical Officer, he had been engaged adjusting his radar unit before the accident – possibly even for a longer period – is not comprehensible. Due to the unproblematic weather, which in particular did not make high demands on the correct anti-clutter control, this could not have required a great expenditure of time from a nautical officer familiar with the unit.
The correctness of the statement that the officer worked on or with the radar unit, respectively, is in particular argued against by the fact that in this connection the dangerous and steadily increasing approach of the coast that was associated with the actual course of DORIA and which shortly before the accident was less than 0.5 (!) nm should have become obvious.

7.1.3 False estimation of the track of the vessel

Apart from the omissions concerning a continuous determination of the position, a lack of nautical understanding concerning the dependence on the rate of speed, the diameter of the turning circle and of a course ahead also promoted the accident.
The Master made clear to the BSU that at the time of the alteration of course to port he had known that DORIA was no longer on the course line that had originally been planned, but closer to the coast. Whereas the only problem was that he overestimated the speed of DORIA. Due to the reduced speed her (partial) turn was completed much earlier and thus at a closer distance to the shore than had been expected.
These conclusions are based upon the misconception that the size of the turning circle with the same rudder angel and state of loading would be absolutely dependent on the speed at the start of the circle. However, as has been shown by various studies, this is not the case with certainty. In fact the centrifugal forces increase quadratic with the increasing speed of the vessel, but a balance is achieved by the simultaneously increasing hydrodynamic forces caused by the rudder angle and the angle of yaw as well as by the curve of the track. The same applies, with reversed signs, in case of a decrease of the original speed.

But for the headway, the facts are different. This indeed is depending on the speed, however, not necessarily in the sense of a proportional increase or decrease. On the contrary, studies have shown that with some vessels the distance covered ahead at first decreases with increasing speed, but then increases again.
To sum it up, one may say that the angle velocity of the course shown by the compass in each case increases with the speed of the vessel, so that after passing the same turning circle at double speed also the double speed of alteration of course is shown, that is, a better reaction of the rudder is felt. But at a higher original speed, the track of the turning circle as such can nevertheless be similar to that of a slower original speed.[39]
Thus, even a presumable overestimation of their own speed should not have resulted in the assumption that DORIA during the turn significantly moved off the shore, due to the lack of an imperative physical connection.

7.2 Cover of the area of the accident by charts

In connection with the navigational deficits that were the main cause for the grounding it was already pointed out that these were considerably encouraged by the lack of a coastal chart with a medium scale. Before discussing the relevant problems in detail, at first a general insight shall be given, for a better understanding, into the foundations of the applicable system of international provisions and agreements on the field of the issue of nautical charts.

7.2.1 Basic principles

7.2.1.1 Legal obligations according to SOLAS

From SOLAS V Rule 9 No. 1 it follows that the governments of the contracting member states must take care of the collection and coalescence of hydrographic data as well as the publication, distribution, and updating of any nautical information that are required for safe navigation.
In particular No. 2.2 of the mentioned Rule prescribes the obligation to prepare and issue charts that meet the requirements of safe navigation. In this connection the utmost uniformity must be ensured following Rule 9 No. 3. Relevant international decision and recommendations shall be taken into consideration as far as possible.
The Plenary Assembly of the United Nations 1998 and 2003, in its resolutions A/RES/54/33 and A/RES/58/240, emphasised the great importance of government activities within the scope of the collection of hydrographic data and the issue of charts for the safety of navigation.
Major deficits in the implementation of the mentioned legal provisions and recommendations caused the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) in 2005, as a reaction to a proposal by the International Hydrographic Organization (IHO) to issue a circular letter[40] in which the governments of the contracting member states of SOLAS are reminded of the existing international obligations and of measures for their implementation.

[39] Seemannschaft Volume 3, Schiff und Manöver, page 272 f. with other notes.
[40] Cf. MSC/Circ. 1179 dated May 24th, 2005.

7.2.1.2 IHO

The International Hydrographic Organization (IHO) was founded in 1921 as a forum for the co-operation of hydrographic services of various seafaring nations and obtained the status of an international organization in 1970 with a permanent headquarter in Monaco. Its members are representatives from more than 70 states. The IHO coordinates the activities of the hydrographic services of its members and strives for the creation and observation of the greatest possible common standard for the issue of nautical charts and other nautical publications. Other tasks are the implementation of reliable and efficient methods for the collection of hydrographic data and the promotion of scientific research in the fields of hydrography and oceanography.[41]

7.2.1.3 Standards for charts

The IHO passed a regulation for charts which, according to the implementation of the above mentioned Rule 9 No. 3 of SOLAS V, includes, among others, recommendations on the necessity of the issue of nautical charts in different scales, depending on their intended use.[42]
For nautical charts on paper (here: International Charts (INT)) the following categorization is planned, which, however, has only the quality of a regulation and allows deviations depending on and appropriate for local circumstances[43]:

Category	Scale	Use	Comments by IHO
Harbour	up to 1:30,000	Harbour entrance, navigation in ports and bays, on rivers, canals and at anchorages	
Approach	1:30,000 to 1:75,000	Approach to harbours; navigation in traffic separation schemes and on main traffic routes	For uncomplicated approaches, the provision of separate approach charts is not imperative; in such cases, the harbour charts should cover a sufficient coastal area in order to ensure a safe transition to the respective coastal chart.
Coastal	1:75,000 to 1:350,000	Coastal traffic	It is desirable that adjoining charts are issued in the same scale in order to facilitate the carry-over of the position for the nautical officers during the change of charts.
General	1:350,000 to 1:2,000,000	Identification of coasts and planning of routes within an ocean / sea	
Overview	1:2,000,000 and above	large-scale planning of routes with crossing oceans / seas	

[41] Cf. www.iho.shom.fr.
[42] Cf. M-4 Part B of the Regulation on Nautical Charts.
[43] Source: Guidance for Preparation and Maintenance of International Chart Schemes.

7.2.1.4 Status of hydrographic data collection and coverage by charts

The IHO runs a permanently updated digital database, in which the situation of the world-wide data collection, the coverage by charts and the distribution of nautical warning messages and corrections of charts are recorded. The database contains information on more than 80 percent of the world-wide coastal waters and tries hard to obtain any missing data. The evaluation of the data collection showed that up to this day in 45 percent of the coastal waters, only less than one third of the respective areas with depths up to 200 metres has been surveyed according to modern standards. In Central America, Western and Southern Africa, in the Indian Ocean and in the South-Western Pacific, the situation shows a particular deficit.
The IHO Publication S-55 ("Status of hydrographic surveying and nautical charting world-wide")[44] is an extract of the mentioned database and via the internet delivers generally available important information and data concerning the availability and quality of nautical charts world-wide.

7.2.2 Angolan Coast / Approach to the Harbour of Namibe

In the Investigation Section (cf. above point 6.3) it was already explained that for the area of the accident only two nautical charts were available. In this connection, the plan of Baia de Mossamedes (Namibe) shown on about half the chart No. 1197, apart from the approaches to Porto de Benguela and Baia dos Elefantes, must virtually fulfil the double function of a harbour and an approach chart.
With its scale of 1:25,000, the plan of Namibe is in principle not within the above mentioned range of scales recommended for approach charts. However, if considered alone, this can be justified, as the approach to Namibe itself does not present any particular nautical difficulties.
The critical problem is rather that, although the provision of an approach chart meeting the international recommendations in the scale between 1:30,000 and 1:50,000 is renounced, it must be guaranteed, that the harbour chart covers a sufficient offshore area in order to enable the nautical officer to perform a safe transition to the coastal chart. But this in turn imperatively requires that a coastal chart in a recommended scale between 1:75.000 and 1:350.000 is existent at all. However, this exactly is not the case for the area of the Angolan coast to be viewed. On the contrary, nautical officers are forced to use the chart No. 627 for the navigation in this coastal area, which at a scale of 1:1,000,000 was intended for the use as overview chart or for the navigation on the open sea, but is completely unsuitable for offshore navigation.[45]

The mentioned deficits coincide with the statements made in the above mentioned IHO Publication S-55.[46] With respect to of the status of the coverage by nautical charts, the publication includes the following statements for Angola, which is not a member of IHO, but as a contracting member state of SOLAS is indirectly bound by the recommendations of the former:

[44] Published on www.iho.shom.fr.
[45] As a proof, cf. also the explanations and figures shown above in point 6.3.
[46] Last revised: July 7th, 2006.

Chart Category	Offshore passage (small scale)			Landfall Coastal passage (medium scale)			Approaches/Ports (large scale)		
	A	B	C	A	B	C	A	B	C
Coverage in percent	100	0	0	60	0	0	100	0	0

A = INT series or national equivalent of the Standard M-4
B = Raster nautical charts (RNC's) of the Standard S-61
C = Electronic nautical charts (ENC's) of the Standard S-57

The publication points out that the waters of Angola are covered by Portuguese charts that were issued mainly before 1974 and need an update.

The publication S-55 includes the following information for the Angolan waters concerning the extent of the collected hydrographic data stock:

Quality level of the data stock	Appropriate collection		Repeated collection on required for larger scales or with more up to date methods		So far no systematic collection	
Depth of the water (metres)	0 - 200	above 200	0 – 200	above 200	0 – 200	above 200
Coverage (percent)	50	3	48	10	2	87

Thus, it may be deduced from this statements that at present only about 50 percent of the Angolan waters with a depth of up to 200 m have been surveyed with an appropriate quality.
Besides, in the notes to the tabular statements, the IHO explicitly points out that due to movements of the soil a repeated survey of the shoal of BAIXO AMELIA is required.

7.3 Evaluation of the general conditions

The weather and seaway had no significant influence on the marine casualty.
With respect to the Master's and the 3rd Nautical Officer's qualifications and experience, no aspects promoting the accident could be detected either.
On the other hand, the evaluation of the working hours and rest periods showed that the 3rd Nautical Officer, contrary to the Master, in the two examined weeks preceding the time of the accident had exceeded the maximum working hours in each period of 7 preceding days. In addition, he had been in use on board for more than eight months. Nevertheless, it can be assumed that the Officer in charge's threshold stress should not have had any critical influence on the development of the accident. This assumption is supported, on the one hand, by the fact that the minimum rest periods were observed, but in particular by the fact that the insufficient assistance provided to the Master by the Officer in charge during the voyage in the area was not due to fatigue, but, according to the facts, most probably was due to a false understanding of the extent of the duties of a Nautical officer immediately before he takes over the watch and while he is assisting the Master on the bridge.

7.4 Measures taken after the accident

The measures taken after the accident were appropriate. Thanks to the concerted co-operation between the bridge, the engine room, the vessel operator and the agencies the voyage could be continued to Durban.
The decision against a return to Namibe and for the continuation of the voyage of DORIA was already taken by the bridge team of the vessel in agreement with the vessel operator and the classification society shortly after the vessel got clear of the shoal. The classification society issued the required exemption permit. The basis for the decision to continue the voyage was that neither the cargo holds nor the engine room were affected by leakages. In addition, tests of the main engine and of the steering gear had confirmed their unrestricted operativeness. Whereas they renounced an inspection of the underwater hull by a diver before the continuation of the voyage, which would have provided a safe and short-term information on the considerable damage to the double bottom of DORIA, which later gradually became obvious.

7.5 Docking

Any mistakes and omissions during docking in DORIA in Durban that resulted in the spillage of harmful substances were not a subject of this investigation. However, generally speaking, the principles of an appropriate distribution of the risk argue in favour of the fact that with the begin of docking in, the responsibility for a vessel and for the dangers originating from her will pass over to the shipyard at least to the extent as the latter is able to make provisions by means of an orderly preparation of the repair order based upon a sufficient analysis of the damage.

7.6 Summary

The marine casualty of DORIA shortly after leaving Namibe is mainly due to navigational omissions. The renunciation of the due continuous determination of the position to the favour of a rough estimation of the position only based upon GPS soundings to the way-points they were heading for, on the top of that during the voyage in the area, almost inevitably resulted in the grounding. The Master was not assisted by the designated Officer in charge, whose tasks should have included to duly make himself familiar with the navigational situation already before the take-over of the watch which was directly lying ahead. One determination of the position only by the Officer in charge within about 5 minutes after entering the bridge would have been sufficient to timely recognise the development of the course of DORIA which was risky from the very beginning.

The false understanding of the effects of the speeds of the vessel and of the rudder angles on the course of the vessel contributed to the development of the accident, but the importance of this fact is clearly minor. Deliberations on the complex connections which influence the track of a vessel during an alteration of the course are in no case suitable to replace an orderly determination of the position before and after each major alteration of course.

The trigger moment for the insufficient determination of the position of DORIA was most probably the completely insufficient supply of nautical charts in the area of the accident. The lack of a chart of the coasts of medium scale and the understandable intention to visualise the oncoming course of the route lying ahead caused the Master to prematurely change over from the large-scale harbour chart (No. 1197) to the small-scale overview chart (No. 627). Hereby the shoal to be passed got out of sight.

The decision to "skip" way-point No. 3 which had duly been planned by the 3rd Nautical Officer (and the subsequent way-point No. 4), possibly was also the result of a precipitate misinterpretation of the nautical chart No. 1197 and its scale. At glimpse of the chart, way-point No. 3 indeed seems to have been selected at a very large-scale distance from the northern cape of the shoal of BAIXO AMELIA. But at a more exact look it should have become obvious that the distance the 3rd Nautical Officer selected for the passage when he planned the routes was between one and somewhat more than two nautical miles, that is, in no way over-dimensioned.
In addition, it must be taken into consideration in this context that due to the old age and obsoleteness of the data from the nautical charts dating back to the colonial age there would have been an additional reason why to circumnavigate the sandbank at a distance as far as possible.
This applies even more if one takes into consideration that sandbanks can be subject to shifting movements and in addition the chart itself includes an indication of its restricted reliability. It is true, this originally refers to the existence, position and lighting of sea marks, but together with the indication of the source of the data in the chart (Portuguese Government 1940) it would also have to be considered more generalising as another indication for the untrustworthiness of the chart and as a warning against navigating at a too small scale.

Finally, it must be considered that according to Section A-VIII/2 Part 2 STCW-Code the planning of the voyage must be checked before starting the voyage. If the Master had followed this rule in a sufficient manner, he would have been able to recognise that the positioning of way-point No. 3 was indeed justified, in order to ensure a safe passage of the shoal of BAIXO AMELIA taking into consideration the foreseeable and unavoidable difficulties in the transition between two adjoining charts.

The measures taken by the bridge team of the vessel after the grounding aimed at ensuring the safe continuation of the voyage of DORIA and keeping the pollutions of the environment within close limits. The bridge team of the vessel achieved this goals in close co-operation with the technical crew on board and with the vessel operator in an ideal manner.
There are no omissions to be stated in this respect. But, it must be admitted, if an inspection of the underwater hull had been carried out before the continuation of the voyage, the decision for this would have been provided a more reliable basis for these actions.

8 Measures taken by the vessel operator after the accident

The vessel operator co-ordinated the voyage of DORIA to Durban in close contact with the bridge crew, the charterer, the insurance company and representatives of agencies and organised the vessel's repair.

The lengthy stay in the shipyard was used to modernise the radar system of DORIA by integrating two modern ARPA radar units and an electronic nautical chart system (ECS, Non-ECDIS).

The vessel operator is presently building a bridge simulator of their own for their fleet, in which regular training of the nautical staff can be held as of 2007.

9 Safety Recommendations

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

1. The Federal Bureau of Maritime Casualty Investigation (BSU) points out to the bridge teams **of vessels** that the determinations of the positions at regular intervals are indispensable for the safety of the vessel. The frequency depends on the respective situation of the traffic. In particular during the voyage in the area it is required to determine the position of the vessel at short intervals. Before and after major alterations of the course, it is indispensable, in any case, to make sure of the position of the vessel. A look onto the GPS receiver and the deviations indicated there from a stored route or the mere determination of soundings and distances to the following way-points are insufficient for this. It is required to check the obtained position by entering it into a nautical chart having a scale as large as possible.

2. The Federal Bureau of Maritime Casualty Investigations warns the bridge teams **of vessels** of the dangers that may result from the inadequate availability of suitable charts or the premature transition between adjoining charts. It must be ensured that nautical charts of every scale are on board for each area of the voyage. Any deficits in the availability of nautical charts of a large or medium scale (approaches, coasts) must be compensated for as far as possible by particular circumspection in the selection of the routes and large-scale plotting of the route, while avoiding dangerous approaches to shoals and other obstacles.

3. The Federal Bureau of Maritime Casualty Investigation recommends the **nautical officer responsible for the planning of the routes** to fix way-points (transfer points) which can be entered on both charts for the transition between adjoining charts. In order to avoid any errors and inaccuracies in the carry-over of way-points and course lines, in particular if the adjoining charts are of different scales, it is recommended to fix transfer points, if possible, at the transit through “even” minutes of longitude and/or latitude, which can easily be localised in the chart depending on its respective scale.

4. The Federal Bureau of Maritime Casualty Investigation calls the **Masters** attention to their supervisory function for the planning of the routes of their vessels. Any planning delegated to a nautical officer must be verified in time before the begin of the voyage. Short-time deviations from a planned route may be required depending on the situations and then have to be performed resolutely. However, alterations of routes that only aim at “taking a short-cut” for the carefully considered and planned route and are not carried out as a necessary reaction to a particular traffic situation, are only admissible after exactly balancing the benefits and risks.

5. The Federal Bureau of Maritime Casualty Investigation points out to the **nautical officers in charge** that even before taking over the watch they are obliged to obtain a comprehensive view of the nautical and navigational particularities of the sea waters as soon as possible after entering the bridge. Among others, this also includes informing themselves about the position of the vessel, her course and any pending alterations of the course. Any open points or doubts concerning a safe position or route must immediately be clarified with the Master operating the vessel or the Officer in charge to be relieved, respectively.

10 Sources

- Witnesses' statements/correspondence
  - Vessel operator Niederelbe Schiffahrtsgesellschaft mbH & Co. KG Buxtehude (NSB)
  - Master of CMS DORIA
  - 3rd Nautical Officer of CMS DORIA
- Ship's and engine log of CMS DORIA
- BA Charts No. 627 and 1197 used on board CMS DORIA
- Time sheets for the Master and the 3rd Nautical Officer of CMS DORIA
- Photograph of the vessel provided by the vessel operator
- South African Maritime Safety Authority (SAMSA): Internal examination report on the oil spill of DORIA in the ELDOCK floating dock in Durban, November 2005
- Germanischer Lloyd: Survey Statement dated March 17th, 2006
- Germany's National Meteorological Service (Department Marine Meteorological Services): Official Expert Opinion dated December 6th, 2005, on the Weather and Seaway Conditions in the Area of the South Angolan Atlantic Coast on October 20th, 2005,
- International Hydrographic Organization (IHO); www.iho.shom.fr:
  - General information about the organization
  - Excerpts from the publication S-55 "Status of hydrographical surveying and nautical charting world-wide"
- International Maritime Organization: MSC/Circ. 1179, May 24th, 2005 "DEFICIENCIES IN HYDROGRAPHICAL SURVEYING AND NAUTICAL CHARTING WORLDWIDE AND THEIR IMPACT OF NAVIGATION AND PROTECTION OF THE MARINE ENVIRONMENT"
- Scharnow (ed.) et al.: Seemannschaft 3 "Schiff und Manöver", [Maritime Navigation 3 "Vessel and Manoeuvre"] 3rd edition, transpress-Verlag 1987

11 Copyright Notices

This investigation report includes illustrations by extracts of work subject to copyright protection.
The photographs used were published by courtesy of NSB vessel operator and of the South African Maritime Safety Authority (SAMSA).
The presentation of the section of the BSH chart No. 2701 for the illustration of the scene of accident is by courtesy of the Federal Maritime and Hydrographic Agency.
The revision and publication of the sections from the British nautical charts (BA Charts) Nos. 627 and 1197 exclusively serves for the indispensable critical analysis of their quality, contents, and applicability for the navigation in the area in which the accident occurred, relevant for the accident. It is limited to the strictly necessary extent and therefore did not require a special permission (cf. art. 51 of the German Copyright and Chapter III "Acts Permitted in relation to Copyright Works" No. 30. "Criticism, review an new reporting" of the British Copyright.)[47]

The Federal Bureau of Maritime Casualty Investigation points out that the use of the figures of this report by any third party for purposes other than those expressly permitted by the copyright is prohibited and may result in consequences under civil as well as under penal law.

For the aforementioned reasons, but also from the point of view of safe navigation, it is strictly prohibited to use the sections from the nautical charts shown (for instance, by means of reproduction) as a basis for the navigation.

[47] Cf. the "Gesetz über Urheberrecht and verwandte Schutzrechte (Urheberrechtsgesetz)" [Law on Copyright and related proprietary rights] dated September 9th, 1965 (BGBl. I page 1273), last amended by the "Gesetz zur Regelung des Urheberrechts in der Informationsgesellschaft" [Law on the Regulation of the Copyright in an Information Society] dated September 10th, 2003 (BGBl. Part I/2003, page 1774 ff., amended I/2004, page 312) and The Copyright, Designs and Patents Act 1988 as amended by The Copyright an Related Rights Regulations 2003, in force since October 31st, 2003.