



Danish Maritime Accident
Investigation Board

MARINE ACCIDENT REPORT

January 2015



DIVER MASTER
Foundering on 4 August 2014

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Front page: DIVER MASTER towing KRUZENSHTERN. **Source:** KRUZENSHTERN.

The marine accident report is available from the webpage of the Danish Maritime Accident Investigation Board www.dmaib.com.

The Danish Maritime Accident Investigation Board

The Danish Maritime Accident Investigation Board is an independent unit under the Ministry of Business and Growth that carries out investigations as an impartial unit which is, organizationally and legally, independent of other parties. The board investigates maritime accidents and occupational accidents on Danish and Greenlandic merchant and fishing ships as well as accidents on foreign merchant ships in Danish and Greenlandic waters.

The Danish Maritime Accident Investigation Board investigates about 140 accidents annually. In case of very serious accidents, such as deaths and losses, or in case of other special circumstances, either a marine accident report or a summary report is published depending on the extent and complexity of the events.

The investigations

The investigations are carried out separate from the criminal investigation without having used legal evidence procedures and with no other basic aim than learning about accidents with the purpose of preventing future accidents. Consequently, any use of this report for other purposes may lead to erroneous or misleading interpretations.

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1. SUMMARY

The sail training ship KRUZENSHTERN was scheduled for an early departure from The Tall Ships Races 2014 in Esbjerg, Denmark, on 4 August at 1730. The event did not end until the next day, but KRUZENSHTERN needed to be in time for another event. A fireworks show was planned for later that night and, for safety reasons, the port was scheduled to be closed at 1800.

The tug boats SVITZER HELIOS and SVITZER TRYM had been ordered to assist KRUZENSHTERN on departure. When the time of departure approached, it became uncertain whether SVITZER TRYM would be able to finish another job in due time, and the option of substituting SVITZER TRYM for another smaller tug boat, DIVER MASTER, was accepted by all the parties involved.

DIVER MASTER was acting as the forward tug boat during KRUZENSHTERN's departure. Once they exited the port breakwaters, KRUZENSHTERN prepared for a starboard turn to follow the route through Grådyb Channel. The pilot on board KRUZENSHTERN ordered DIVER MASTER into a one o'clock position in preparation for the turn, but the master of DIVER MASTER lost control of the tug which ended up being dragged by its own towline. DIVER MASTER swung onto, and hit, the side of KRUZENSHTERN. DIVER MASTER capsized and subsequently foundered as a result of flooding.

The investigation has concentrated on the technical aspects of the accident as well as the decision to use DIVER MASTER as a substitute for SVITZER TRYM.

DIVER MASTER was subsequently salvaged but was not put back into service. The owner and master, at the time of accident, is no longer the owner of the company.

2. FACTUAL INFORMATION

2.1 Photo of the ship



Figure 1: DIVER MASTER
Source: BB Towing & Diving

2.2 Ship particulars

Name of vessel:	DIVER MASTER
Type of vessel:	Work boat & tug
Nationality/flag:	Denmark
Port of registry:	Esbjerg
Call sign:	OVJZ
Year built:	1919
Shipyard/yard number:	Lödöse shipyard, Thorskogs, Sweden/1
Length overall:	17.17 m
Breadth overall:	4.33 m
Draught:	2.20 m
Gross tonnage:	33.90
Deadweight:	67 t
Engine rating:	336 kW
Service speed:	8 knots
Hull material:	Steel
Hull design:	Single hull

2.3 Voyage particulars

Port of departure:	Esbjerg, DK
Port of call:	Esbjerg, DK
Type of voyage:	Coastal, national

Manning: 2
Pilot on board: No
Number of passengers: 1

2.4 Weather data

Wind – direction and speed: Westerly – 5-6 m/s
Wave height: 0.2 m
Visibility: Good
Light/dark: Light
Current: 1.5-2.0 knots

2.5 Marine casualty or incident information

Type of marine casualty/incident: Foundering
IMO classification: Very serious
Date, time: 4 August 2014 at 1752
Location: Port of Esbjerg
Position: 55° 28.05' N 008° 25.20' E
Ship's operation, voyage segment: Towing
Place on board: Aft deck
Human factor data: Yes
Consequences: The ship foundered and obstructed the port entrance.

2.6 Shore authority involvement and emergency response

Involved parties: Maritime Assistance Service and Danish Naval Home Guard
Resources used: Two RHIBs¹
Speed of response: Immediately
Actions taken: RHIBs attending the scene of the accident
Results achieved: All persons from DIVER MASTER recovered by Danish Naval Home Guard RHIBs and brought to Esbjerg rescue station.

2.7 The ship's crew

Master: 63 years old. No formal maritime qualifications as a master. Certificate of proficiency in Yachting. Owner and master of DIVER MASTER since 1995.
Mate: 35 years old. Maritime qualification as able seaman, from Poland. A total of 15 years of experience at sea, approx. 10 years with BB Towing & Diving.

¹ Rigid Hull Inflatable Boat.

2.8 Scene of the accident

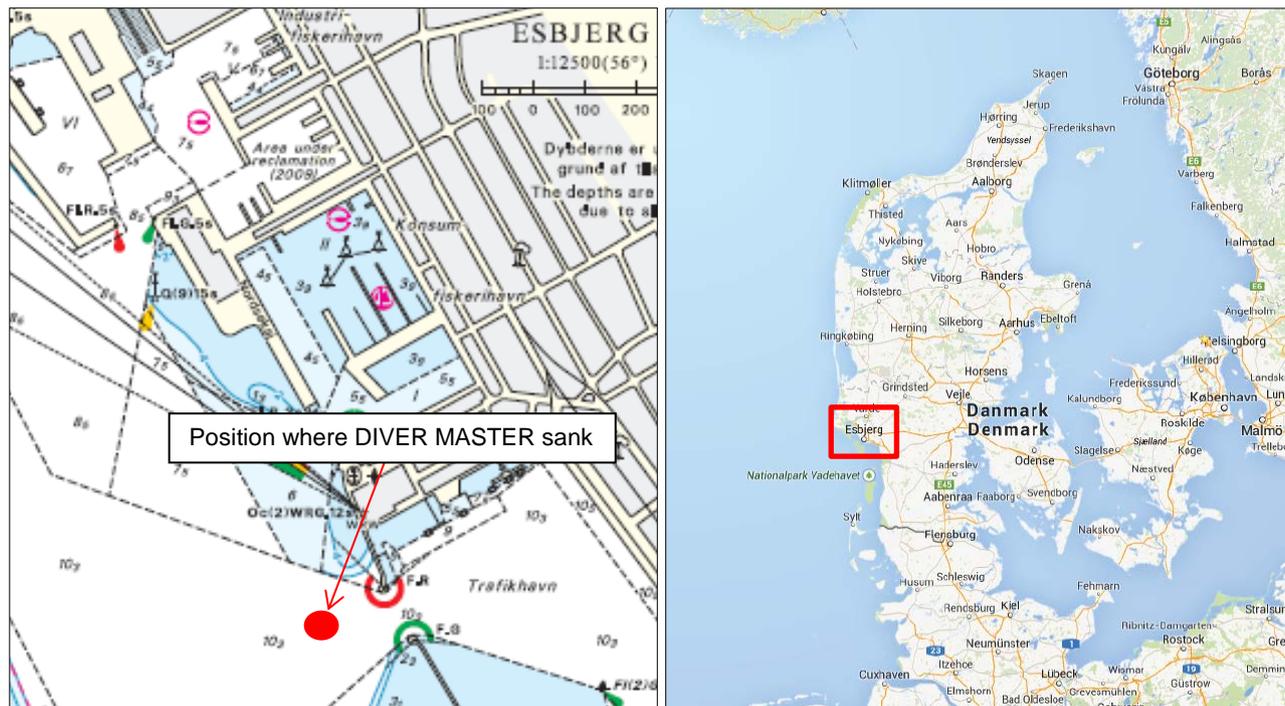


Figure 2: Scene of the accident. Port of Esbjerg
Source: Danish Geodata Agency & Google Maps

3. NARRATIVE

3.1 Background

3.1.1 The Tall Ships Races 2014 event

The Tall Ships Races 2014 event took place in Esbjerg, Denmark, on 2-5 August. The Races had been started in Harlingen, the Netherlands, on 3 July and had scheduled events in Fredrikstad and Bergen, Norway, before finishing in Esbjerg on 5 August with the “Parade of Sails”, where the ships were planned to leave the port together.

A large number of traditional sailing ships participated in the races, including the world’s second largest sailing ship, KRUZENSHTERN.

As a courtesy, the ports hosting the events provided and paid for pilots and tug boats to the tall ships as required or desired by these.

3.1.2 BB Towing & Diving

BB Towing & Diving was a small local contractor business based in the Port of Esbjerg. Various services were offered by the company, including a variety of diving operations and towing of barges and other equipment for construction purposes, etc. Several services were carried out by the work/tug boat DIVER MASTER. A large number of local enterprises and authorities were being serviced by the company, and the Port of Esbjerg formed the basis of a large part of the company’s activities.

3.2 Sequence of events

On Monday 4 August 2014 at 1730, the sail training ship KRUZENSHTERN (figure 3) was scheduled to depart from the Port of Esbjerg, Berth 103. KRUZENSHTERN was the first ship to depart from The Tall Ships Races event. It was customary to depart during the “Parade of Sail” when the participating tall ships left the harbour collectively. However, the “Parade of Sail” was scheduled for the next day and KRUZENSHTERN had to depart one day earlier in order to arrive on time for another scheduled event in Warnemünde, Germany.



Figure 3: KRUZENSHTERN under sail
Source: www.kruzenshtern.info

On Monday 4 August 2014 at 2300, a fireworks show was scheduled to take place in the port. For safety reasons, the local emergency management authorities had ordered the port closed for arrivals and departures from 1800 and until the fireworks show was over. This left KRUZENSHTERN with half an hour to clear the port and be underway before the closing. A pilot and two tug boats, SVITZER HELIOS (figure 4) and SVITZER TRYM, based in Esbjerg, had been ordered by the port to assist KRUZENSHTERN during departure.

On Monday 4 August 2014 at approx. 1700, it was uncertain whether SVITZER TRYM would be able to finish another towing assignment in time to arrive at KRUZENSHTERN and assist with the departure at exactly 1730. Given the time constraints imposed by the planned closing of the port and the uncertainty of SVITZER TRYM, the port master asked the pilot and the master of the ship if they would accept the smaller tug boat DIVER MASTER as a substitute for SVITZER TRYM. The change of tug boat was accepted and, shortly after, the port master contacted BB Towing & Diving to enquire about the availability of DIVER MASTER for the towing assistance to KRUZENSHTERN at departure together with SVITZER HELIOS. The request was immediately accepted by BB Towing & Diving, and DIVER MASTER quickly mobilized and made its way towards KRUZENSHTERN.

At 1710, SVITZER HELIOS made its way from its own berth towards KRUZENSHTERN to assist with the scheduled departure at 1730.



Figure 4: SVITZER HELIOS and RHIBs
Source: www.tallshippesbjerg.dk

At approx. 1725, SVITZER HELIOS arrived at Berth 103. The master was then notified that SVITZER TRYM had been substituted by DIVER MASTER. In accordance with company procedures, the master of SVITZER HELIOS contacted his company office to have the change of plans confirmed and to have the continued towing of KRUZENSHTERN on the changed terms approved. The master was informed by the company that the matter would be looked into and, shortly after, he was called and instructed to continue with the planned towing in cooperation with DIVER MASTER, which had in the meantime also arrived at Berth 103.

Meanwhile, the crew on board SVITZER TRYM had notified the pilot on board KRUZENSHTERN that they had finished their other towing job and would be able to arrive at KRUZENSHTERN within a few minutes to assist in accordance with the original plan. However, the crew on board SVITZER TRYM were informed that there was no time to wait and therefore the departure would be conducted with DIVER MASTER.

At 1730, SVITZER HELIOS and DIVER MASTER were both connected to KRUZENSHTERN; DIVER MASTER at the bow with a towline provided by KRUZENSHTERN and SVITZER HELIOS at the stern with its own towline (figure 5). The towline provided by KRUZENSHTERN for DIVER MASTER, which had considerably larger dimensions than its own towline, was made fast on a bitt on the forward part of the main deck on board KRUZENSHTERN and went through a fairlead forward on the port bow, and down to the towing hook on board DIVER MASTER. Normally, DIVER

MASTER would use its own towline, but this job required approximately 30 metres of length rendering DIVER MASTER's own towline too short.

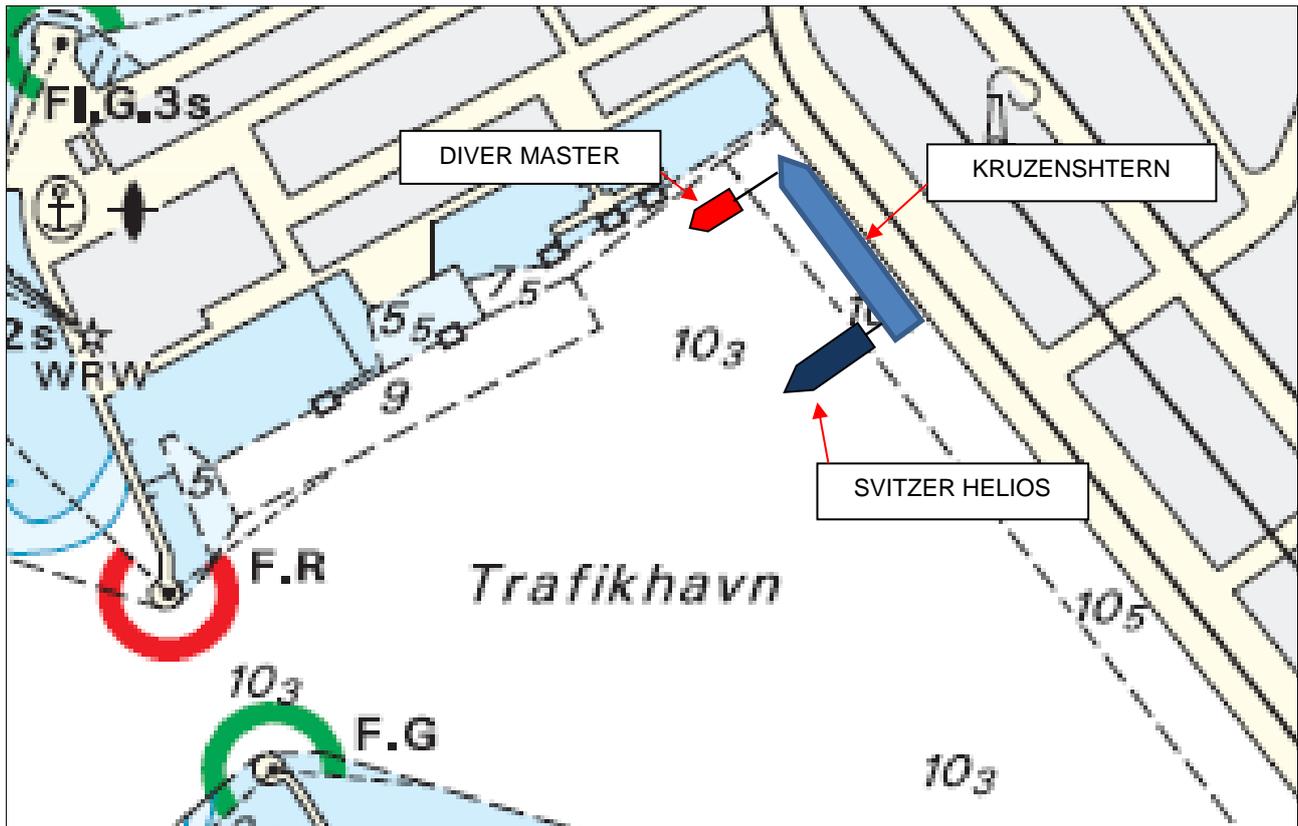


Figure 5: KRUZENSHTERN, DIVER MASTER and SVITZER HELIOS at Berth 103 ready for departure. Not to scale
Source: DMAIB

At 1735, DIVER MASTER and SVITZER HELIOS started pulling KRUZENSHTERN off the berth, both tugs in a nine o'clock position relative to KRUZENSHTERN. DIVER MASTER was ordered to pull at full power and SVITZER HELIOS was ordered to pull with five to ten tons. KRUZENSHTERN's course was then adjusted inside the port to a heading of approx. 245° equal to a course line through the port entrance. DIVER MASTER was then ordered to go straight ahead and the towline on SVITZER HELIOS was slackened and the tug followed KRUZENSHTERN on its port quarter. DIVER MASTER continued at full speed (figure 6), while various rudder and engine power adjustments were carried out on board KRUZENSHTERN to keep on track while exiting the port through the entrance at a speed of approx. four knots (figure 7).

Initially, the master of DIVER MASTER was under the impression that he was only to assist in pulling KRUZENSHTERN off the berth, and he assumed that his involvement in the operation would be over before exiting through the breakwaters of the port entrance. When this assumption proved to be wrong, he continued as he did not find that there was any other appropriate or possible option at that stage.



Figure 6: DIVER MASTER pulling KRUZENSHTERN at full power towards the port entrance
 Source: Private photo from KRUZENSHTERN

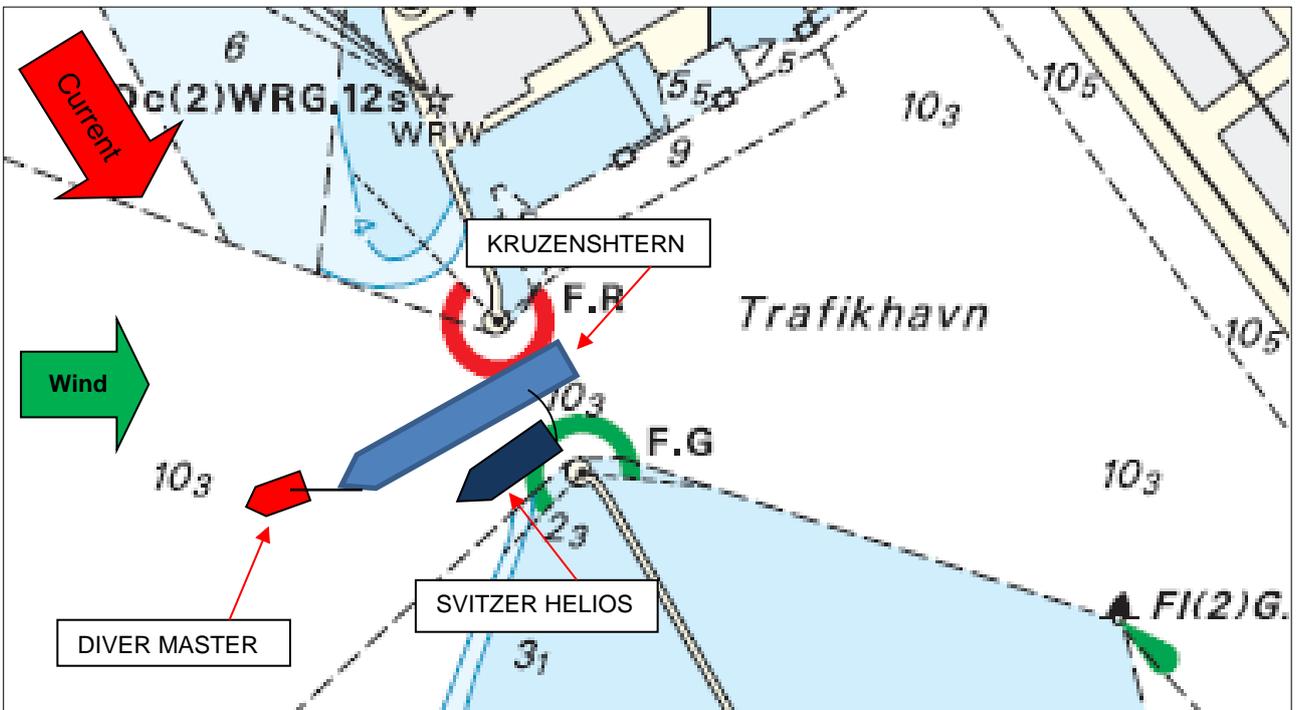


Figure 7: KRUZENSHTERN, exiting the port at 1744
 Source: DMAIB

At 1745, KRUZENSHTERN had passed the breakwaters of the Port of Esbjerg and proceeded at a speed of approximately five knots. The current was running at a speed of 1.5-2 knots in a south to south-easterly direction outside the port in Grådyb Channel. The pilot ordered DIVER MASTER into a one o'clock position to have it in a favourable position for the starboard turn initiated by KRUZENSHTERN to reach a north to north-westerly heading in the channel.

When DIVER MASTER reached the one o'clock position ordered by the pilot, the master quickly became aware that the tug did not behave as he expected (figure 8). KRUZENSHTERN continued on a westerly course at a speed of approx. five knots. The master of DIVER MASTER informed the pilot on board KRUZENSHTERN that he was losing control over the tug as he was now being dragged by KRUZENSHTERN and that the towline needed to be disengaged. The pilot ordered KRUZENSHTERN's engines stopped, and SVITZER HELIOS was released from the stern in order to assist DIVER MASTER.

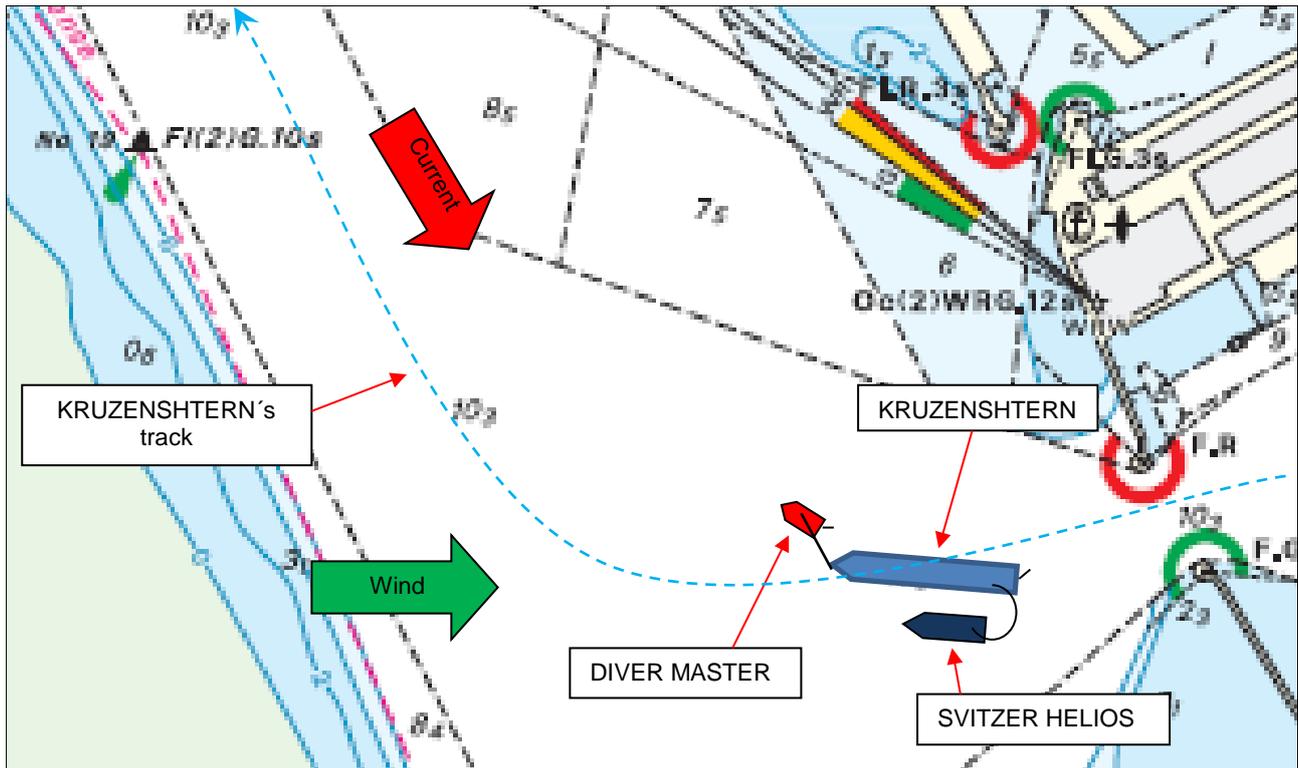


Figure 8: Situation at 1745 with DIVER MASTER in a one o'clock position
Source: DMAIB

The mate on DIVER MASTER was on deck and attempted to release the towline from the towing hook, but the hook did not disengage. DIVER MASTER was dragged in a half circular motion and, at the same time, turning starboard and heeling to port. The towline assumed an athwart ship's position and ultimately DIVER MASTER swung its stern into KRUZENSHTERN's starboard side, leaving the port side of DIVER MASTER in the sailing direction of KRUZENSHTERN (figures 9, 10 & 11). DIVER MASTER heeled further to its port side and capsized, while being dragged along the side of KRUZENSHTERN (figure 12).

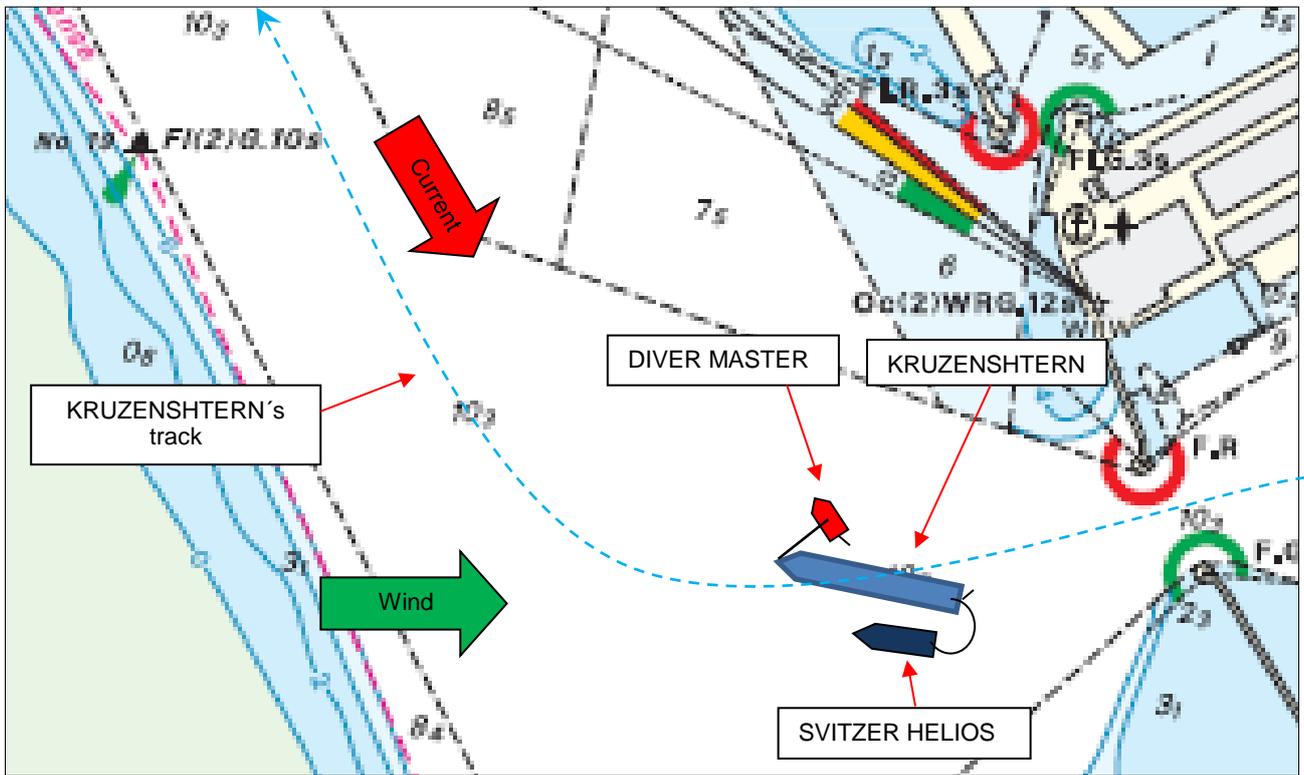


Figure 9: Situation approx. 20 seconds later than shown on figure 8 with DIVER MASTER in a continuing starboard turn while the mate attempted to release the towing line
 Source: DMAIB



Figure 10: DIVER MASTER heeling over and turning starboard
 Source: DMAIB

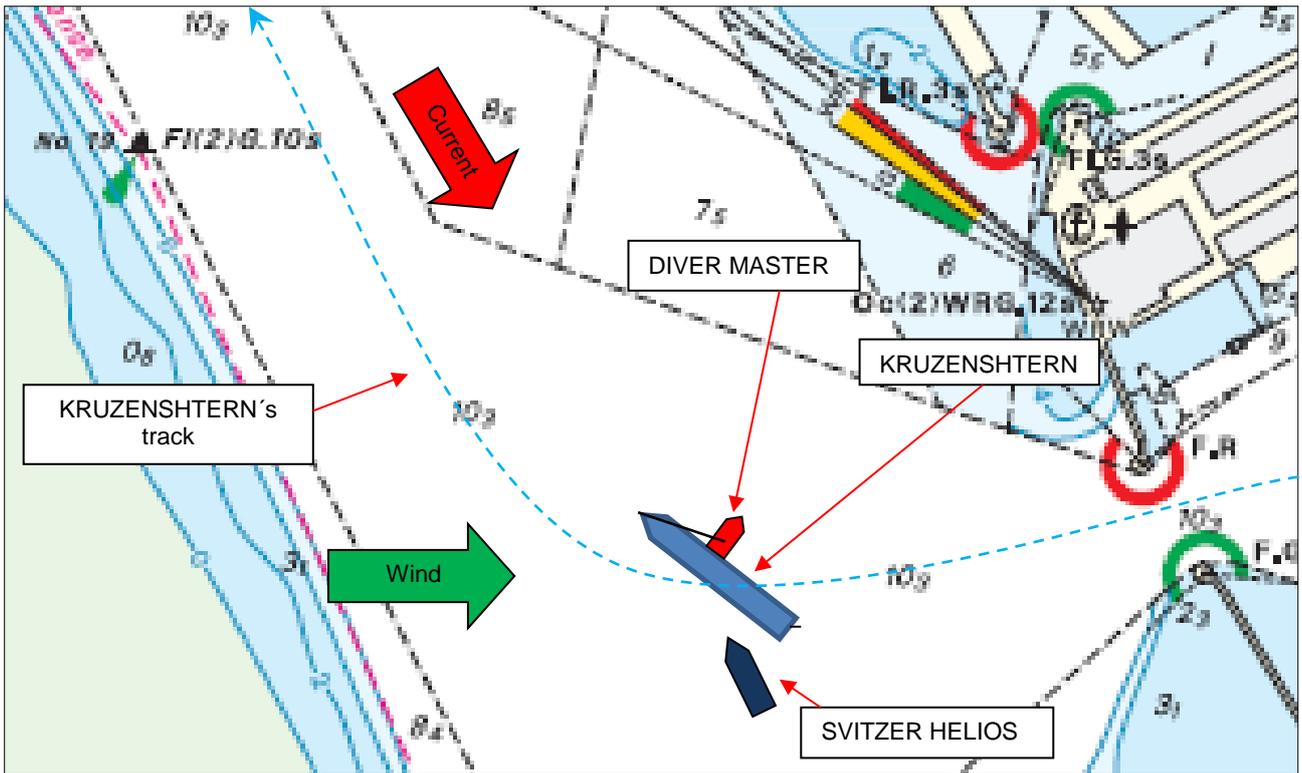


Figure 11: Situation approx. 20 seconds later than shown on figure 8 with DIVER MASTER hitting the side of KRUZENSHTERN with its stern end
 Source: DMAIB



Figure 12: DIVER MASTER capsized and dragged by the side of KRUZENSHTERN
 Source: KRUZENSHTERN

The mate assisted the master of DIVER MASTER and one passenger out of the wheelhouse and onto the starboard side gunwale of the capsized tugboat. Two rescue boats coming from the port arrived at the scene immediately after.

At approx. 1747, KRUZENSHTERN's speed over the ground had been reduced to approx. 1.5 knots and the towline was cut at the bollard on board KRUZENSHTERN by means of a fire axe. DIVER MASTER then drifted down the side of KRUZENSHTERN and the mate and passenger were recovered directly from the drifting tug into one of the rescue boats. The master of DIVER MASTER was subsequently recovered from the water.

At 1748, the pilot on board KRUZENSHTERN informed the Maritime Assistance Service at the Admiral Danish Fleet (MAS) about the accident. A number of manoeuvres were carried out by KRUZENSHTERN to keep a standby position in the Grådyb Channel. The pilot requested an inspection of the ship to establish any damage. It was reported that there was no internal or external damage to KRUZENSHTERN.

At 1752, DIVER MASTER foundered with the stern first in position 55° 28.05' N 008° 25.20' E.

At 1755, the pilot on board KRUZENSHTERN contacted MAS again to give an update on the situation and to ask how KRUZENSHTERN should act. The pilot was advised that KRUZENSHTERN was allowed to continue its voyage towards Warnemünde.

The recovered persons from DIVER MASTER were all brought ashore to the local rescue station at the Port of Esbjerg. The police conducted an alcohol test on the skipper and the mate which were both negative.

3.3 DIVER MASTER

3.3.1 General information and layout

DIVER MASTER was transferred from the register of Honduras to the Danish flag in 2007 by the owner, BB Towing & Diving. The ship was used for various odd jobs such as diving support, towing and transfer of personnel in near coastal voyages during the daytime. The bollard pull was stated at seven tons.

DIVER MASTER was a conventional tug with a fixed propeller and a single rudder fitted aft.

The general layout of DIVER MASTER is shown in figures 13, 14 & 15.

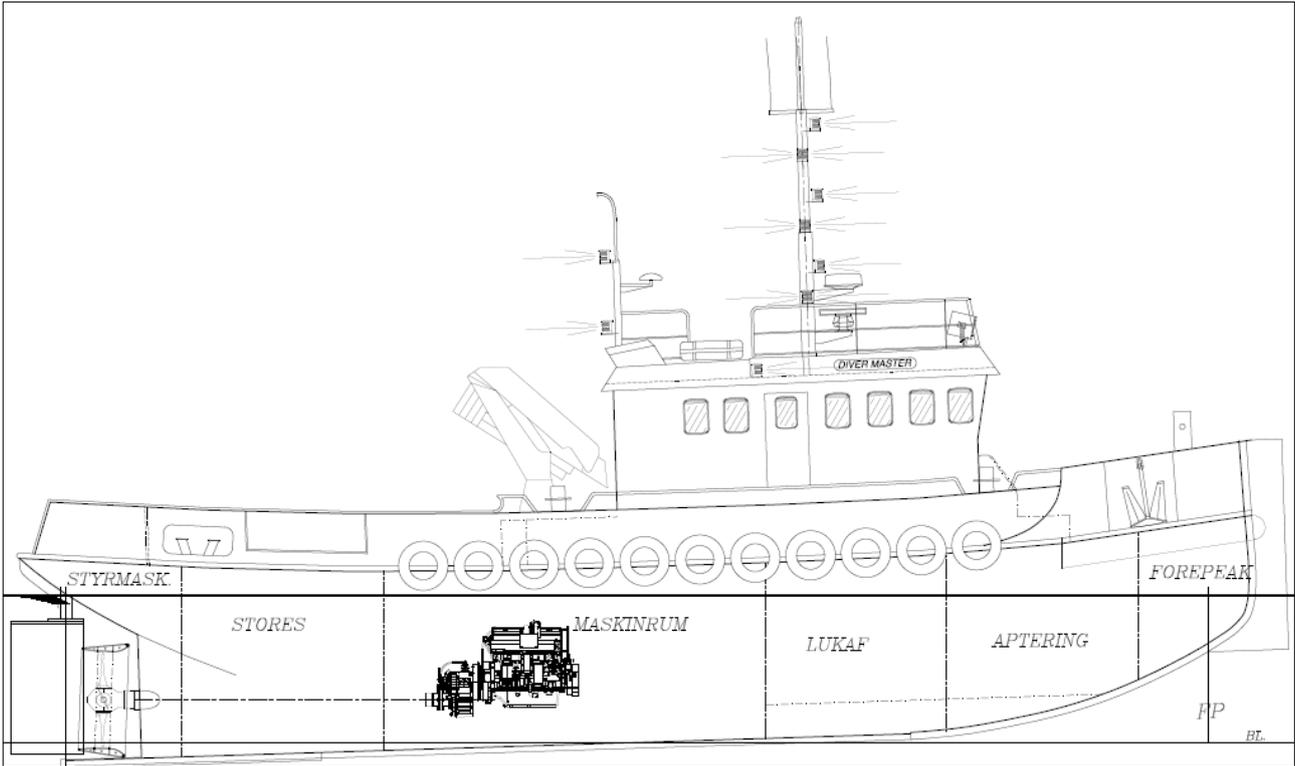


Figure 13: General Arrangement of DIVER MASTER
 Source: BB Towing & Diving

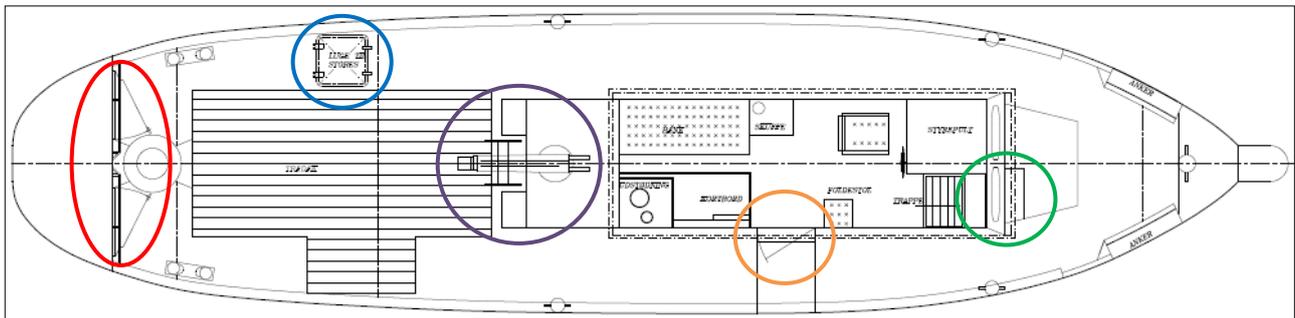


Figure 14: DIVER MASTER main deck. Stores hatch encircled in blue, steering gear room hatches encircled in red, entrance to wheelhouse encircled in orange, emergency exit from accommodation encircled in green, towing hook & gog rope winch encircled in purple
 Source: BB Towing & Diving

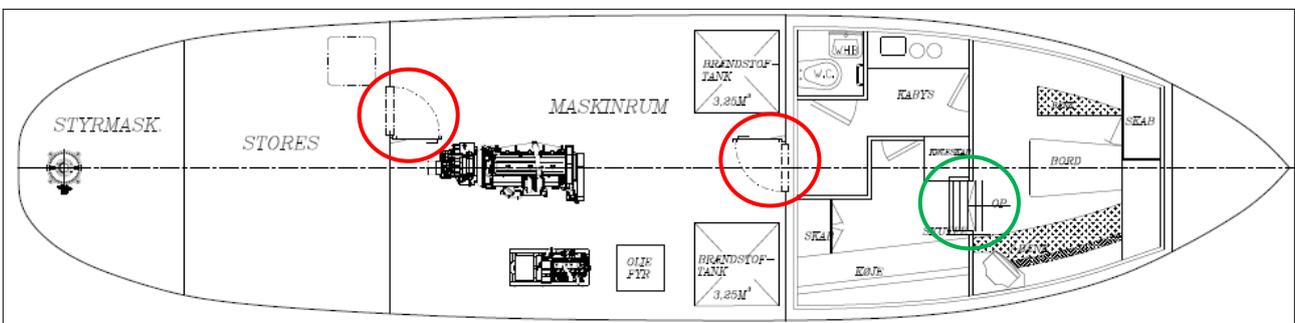


Figure 15: DIVER MASTER below main deck. Engine room doors are encircled in red, stairway to wheelhouse encircled in green
 Source: BB Towing & Diving

DIVER MASTER had the wheelhouse placed forward of the working deck, where the towing equipment was situated. Entrance to the wheelhouse was via a door on the starboard side of the main deck. There was no door on the port side. In the forward end of the wheelhouse, there was a stairway down to the lower deck where the accommodation and engine room were located. This stairway had an emergency exit leading to the forecastle. A watertight door connected the accommodation in the forward end with the engine room. Aft of the engine room there was a stores room likewise connected to the engine room with a watertight door. From the stores room there was a hatch for stores, also serving as an emergency exit, leading to the port side of the aft main deck. On the main deck level, the hatch coaming had a smaller hatch incorporated on the aft side (figure 16). The smaller hatch was open during the accident as seen in figure 17.

The steering gear was located aft. Two hatches on the aft part of the ship led from the main deck to the steering gear room (figure 18).



Figure 16: Stores hatch on the aft deck of DIVER MASTER
Source: DMAIB



Figure 17: DIVER MASTER aft deck with open hatch encircled during the towing of KRUZENSHTERN
Source: KRUZENSHTERN



Figure 18: DIVER MASTER aft deck hatches to steering gear
Source: DMAIB

On 17 August 2014, DIVER MASTER was raised from the seabed and brought alongside in the Port of Esbjerg. The rudder position of DIVER MASTER indicated that the ship had been in a starboard turn when the accident occurred (figure 19).



Figure 19: Stern end of DIVER MASTER after the salvage
Source: DMAIB

3.3.2 Towing arrangement

DIVER MASTER was equipped with a quick-release disc-type towing hook (figure 20). This had been fitted to the ship in 2007 when the ship was transferred to the Danish flag, replacing an existing and older towing hook. The towing hook had been tested and certified by the manufacturer to a test load of 14 tons. It had a corresponding safe working load of 7 tons. The towing hook was designed to be easy to operate, even at full safe working load, as release should be possible with a manual effort of less than a force equal to 15 kg².

² Source: <http://mampaey.com/towing/quick-release-towing-hooks/>

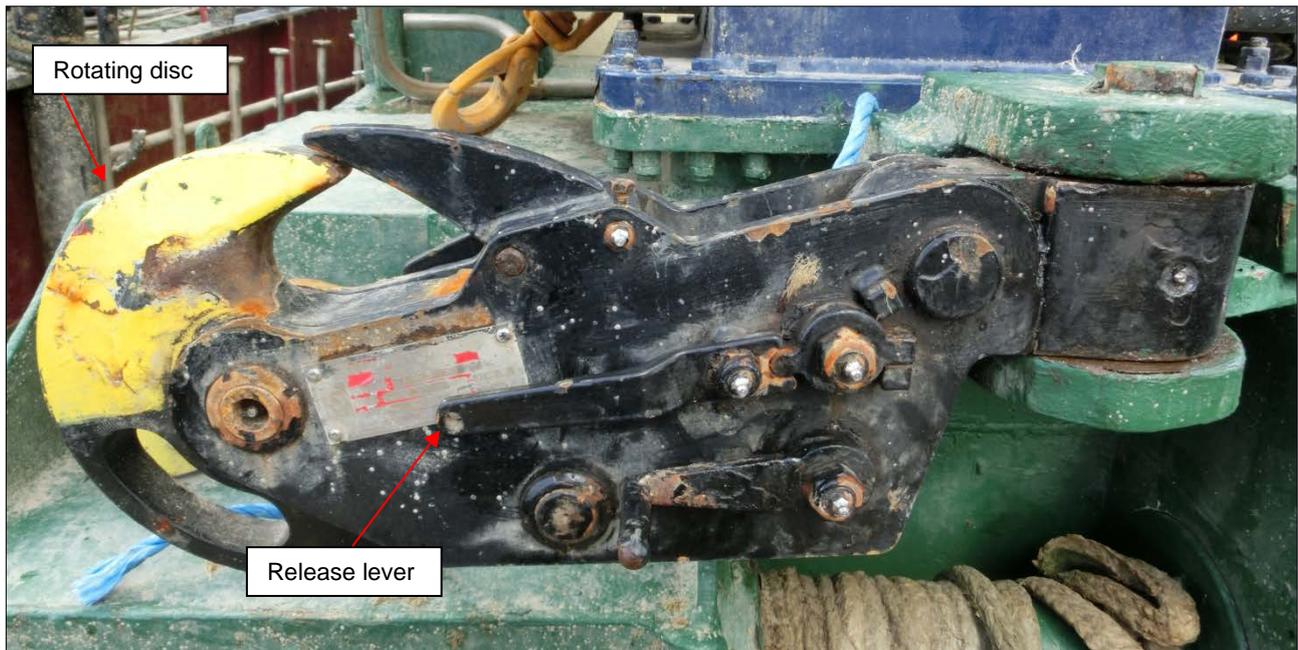


Figure 20: Towing hook on DIVER MASTER. Picture taken after the salvage
Source: DMAIB

The towing hook had a lever for release once the towline had been fastened in it. The release lever could be fitted with a wire for remote manual release of the hook. A specially designed, small fairlead was available as an option for guiding the manual release wire to the wheelhouse³ of a ship. Such a feature was not fitted on board DIVER MASTER due to technical difficulties in guiding the wire to the wheelhouse. The normal procedure on board DIVER MASTER was instead to lead the wire to a bracket mounted on the starboard side of the wheelhouse (figure 21). At the time of the accident, the wire had not been fitted on the bracket and therefore attempts were made to release it from a different position on deck, further aft, as the wire had not been led to the bracket at that time.

During the accident, the towing hook had moved to a transverse and upwards position as illustrated in figure 22 as a result of the tension from the towline.

The towline supplied by KRUZENSHTERN had dimensions barely fitting those of the towing hook as illustrated in figure 23. The release function was tested by the DMAIB with the towline from KRUZENSHTERN, after the salvage. The test showed that release of the hook could be problematic even without tension from the towline as the disc was not able to rotate freely with the towline fitted.

³ Source: <http://mampaey.com/towing/quick-release-towing-hooks/>



Figure 21: Manual remote release wire arrangement on board DIVER MASTER. Reconstruction made after salvage
Source: DMAIB

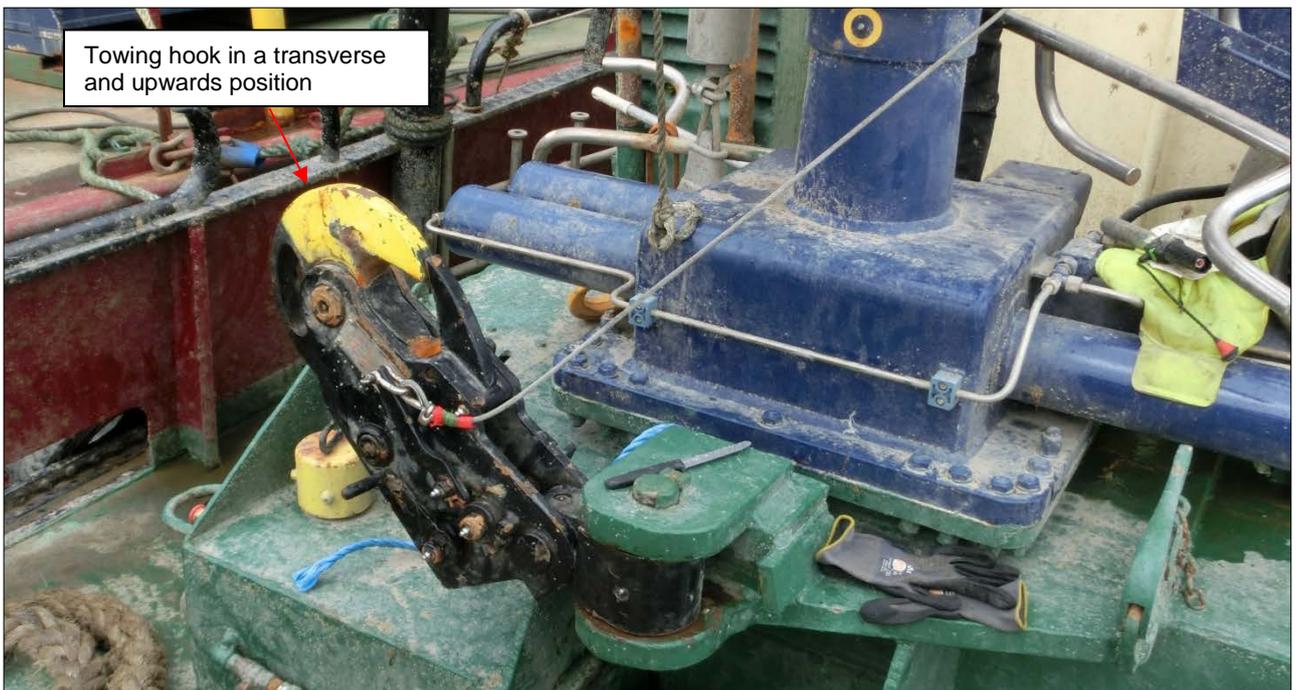


Figure 22: Towing hook in odd position on board DIVER MASTER. Reconstruction made after salvage
Source: DMAIB



Figure 23: Towing hook with towline from KRUZENSHTERN. Reconstruction made after salvage
Source: DMAIB

DIVER MASTER was equipped with a gog rope arrangement, which had the purpose of fixating the towline and thus limiting the transverse movement of the towline away from the centreline of a tug, and offsetting the longitudinal position where the towline leaves the tug, well away from amidships where the towing hook was placed on DIVER MASTER. The effect is a reduced exposure to a phenomenon called girting⁴.

The gog rope arrangement on board DIVER MASTER consisted of a small winch, situated amidships below the towing hook with a connected Dyneema⁵ line, which was led over the deck area through the after side of the ship, and back on board where it was connected to two shackles and a steel ring. The towline would then be led through the steel ring and, when the winch was tensioned, the towline would be held down by the arrangement (figures 24, 25 & 26).

⁴ Girting is the phenomenon where the heeling moment exerted by the towline overcomes the tug's righting lever rendering it susceptible to capsizing.

⁵ Dyneema is a manufacturer of fiber rope of a strength 15 times that of steel on a weight-for-weight basis.

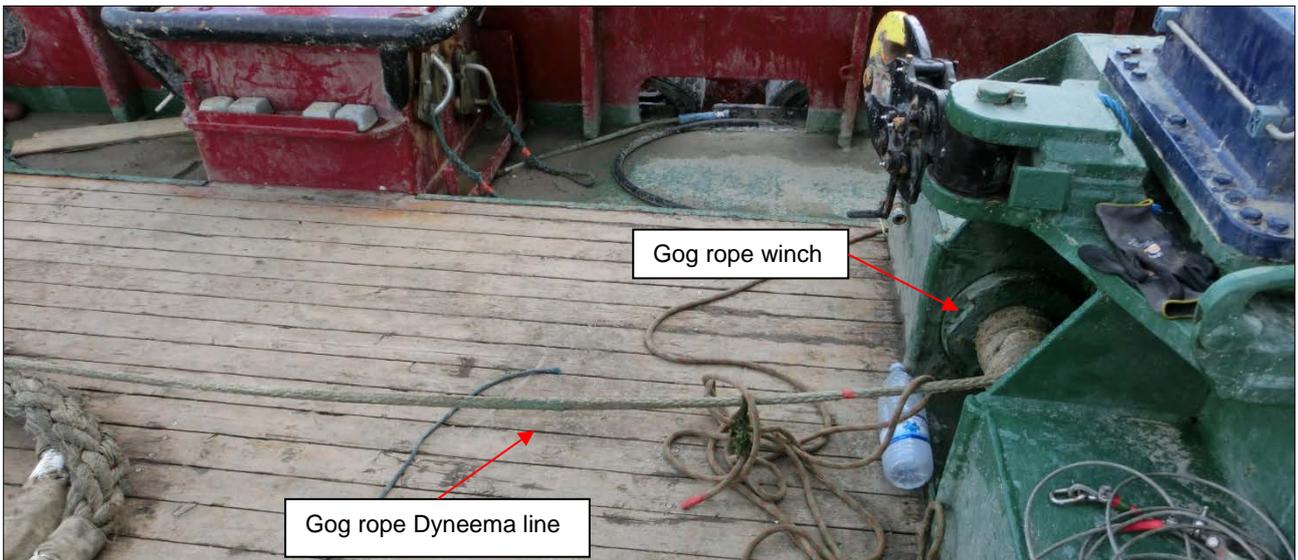


Figure 24: DIVER MASTER aft deck
Source: DMAIB



Figure 25: DIVER MASTER aft deck
Source: DMAIB



Figure 26: DIVER MASTER aft deck
Source: DMAIB

The gog rope arrangement would need to be mounted on the towline prior to towing operations as it would be dangerous, or in the case of DIVER MASTER impossible, to do so when the towline had been made fast on the hook, and under tension.

When in use, the gog rope arrangement would minimize the heeling moment induced on the ship, by transverse tension from the towline, and thus help prevent girting. However, a side effect would be an increase of a turning moment induced on the ship by the tensioned towline causing the hull to rotate around its pivot point by the hook, which would inhibit the tug's ability to manoeuvre easily as illustrated in below figures 27 & 28. This is in particular distinctive on tugs with conventional propeller and rudder located aft as opposed to e.g. azimuth systems.

During the towing of KRUZENSHTERN, the gog rope arrangement was not in use on board DIVER MASTER (figure 29). The DMAIB has been informed that it could be considered as normal practice not to use the gog rope arrangement during this kind of towing operation, when acting as a forward tug without the need to move astern.

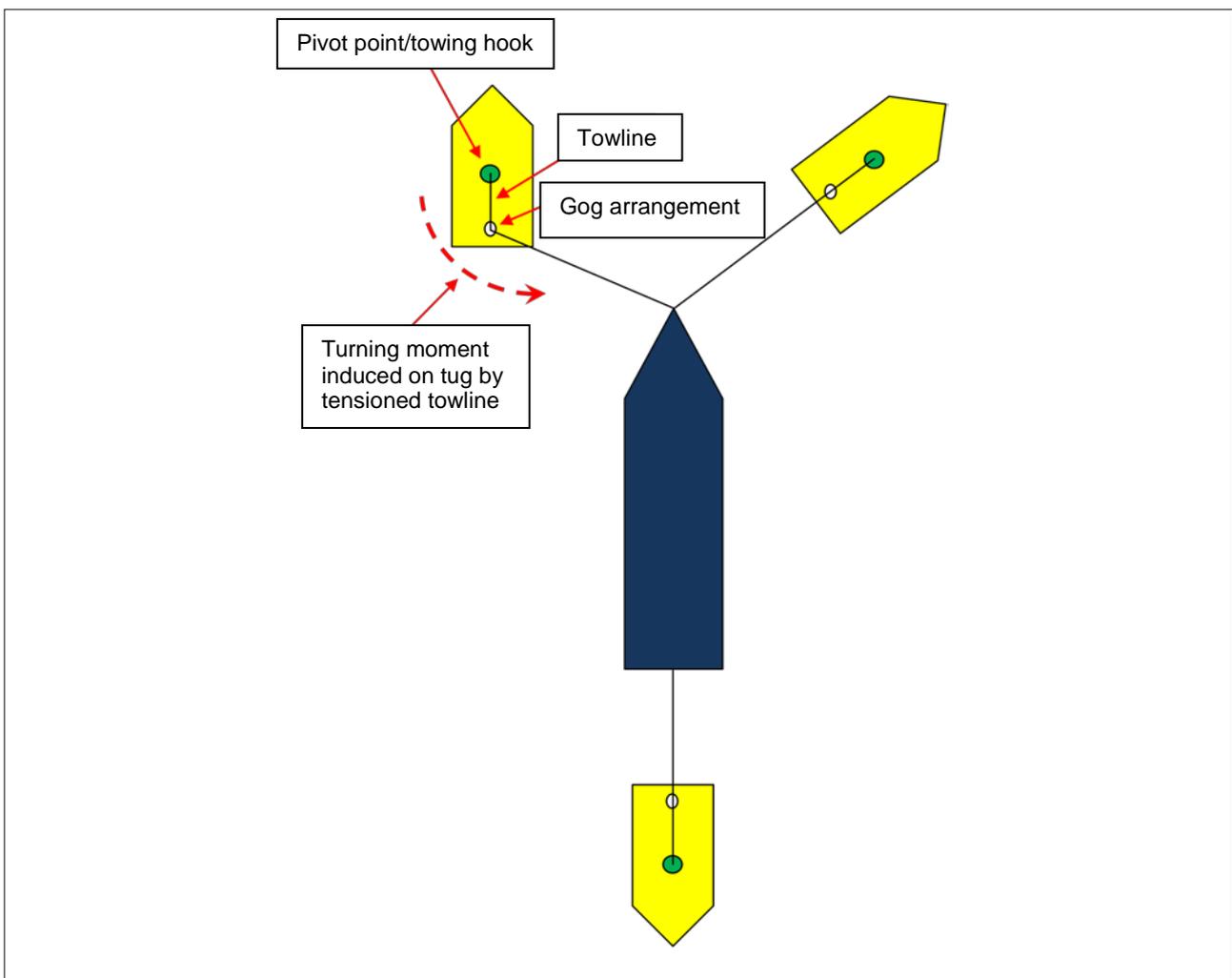


Figure 27: Various situations with a tug boat using gog rope arrangement
Source: DMAIB

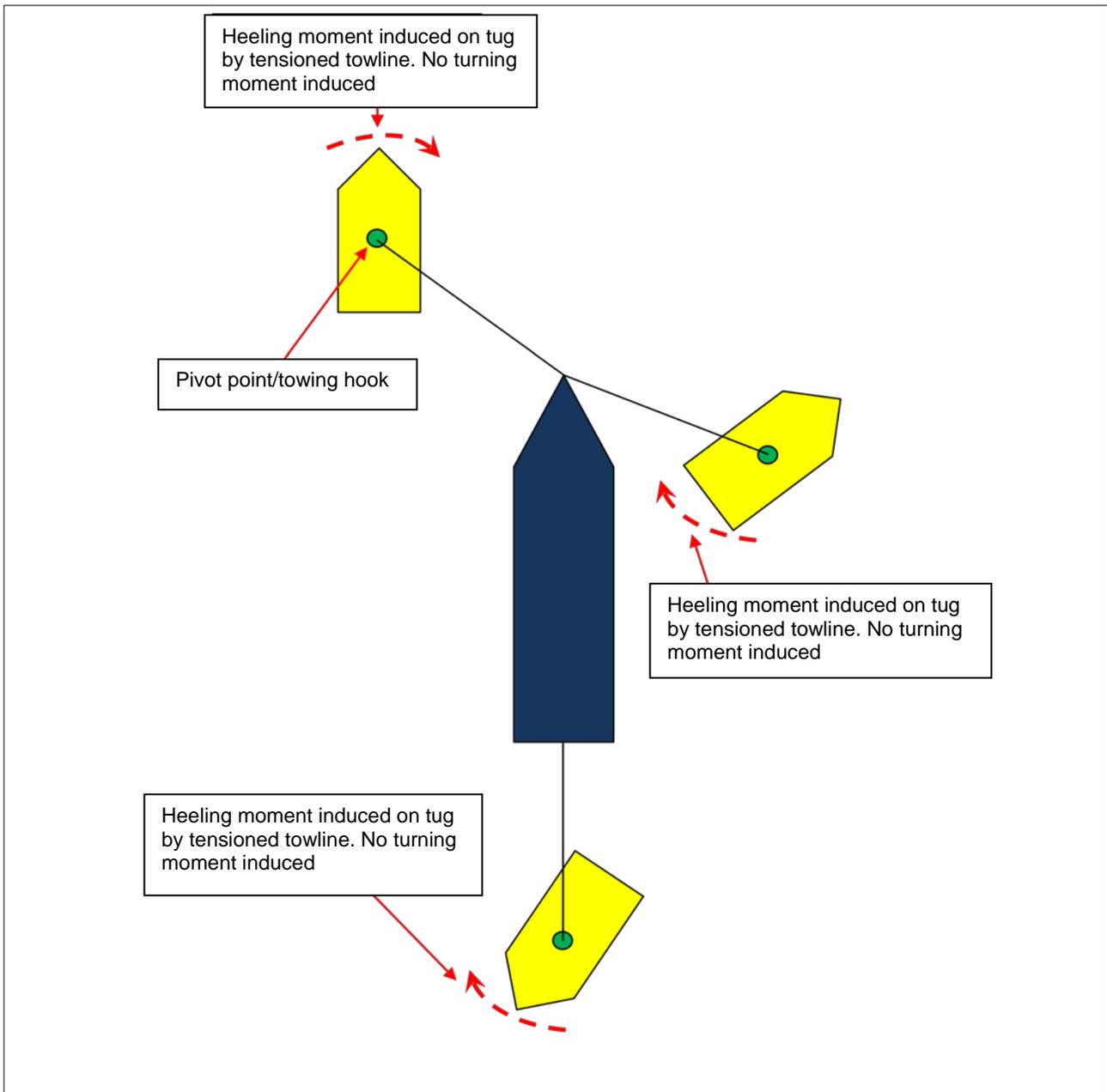


Figure 28: Various situations with a tug boat not using gog rope arrangement
 Source: DMAIB



Figure 29: DIVER MASTER aft deck when towing KRUZENSHTERN towards the port entrance
Source: DMAIB

3.3.3 Inspections and certification of DIVER MASTER

DIVER MASTER was not classed with any classification society. All inspections and certification of the ship had thus been carried out by the Danish Maritime Authority since the transfer to the Danish flag.

The ship had been approved in accordance with Notice B from the Danish Maritime Authority⁶. Additionally, the technical regulation on towing and anchor handling winches and towing hooks in ships⁷ should be applied to towing operations carried out with DIVER MASTER and to the towing hook installed on the ship.

No deficiencies related to the towing arrangement on board DIVER MASTER had been recorded in the survey reports made in connection with the periodic surveys carried out on board at any time while it had been under the Danish flag and the tug held valid certificates at the time of the accident.

⁶ Order on Notice B from the Danish Maritime Authority, technical regulation on the construction and equipment, etc. of ships.

⁷ Technical regulation no. 5 of 13 September 2006 on towing and anchor handling winches and towing hooks in ships.

3.4 KRUZENSHTERN

KRUZENSHTERN was a four-mast bark owned and operated by the Kaliningrad State Technical University in Russia. The ship served as a sail training ship where cadets were trained in basic maritime skills as part of their education. Each year, the sailing plan was made taking into consideration various events in which the ship would participate.

KRUZENSHTERN had a gross tonnage of 3,141, a length overall of 114.5 metres and a width of 14.02 metres. The bowsprit was 14 metres long. On the day of the accident with DIVER MASTER, the ship had a draught upon departure of 6.0 metres forward and 5.8 metres aft.

KRUZENSHTERN was equipped with two main engines with a total maximum power output of 1472 kW, giving a maximum speed of 10 knots. The ship was not fitted with bow- or stern thrusters.

During port operations, it was the general rule on KRUZENSHTERN to make use of tug boats. On the day of the accident, the towline connected to DIVER MASTER was put around a bitt in the forward end of the main deck, from where it was led to a hawsehole and exited the ship on the starboard bow approx. 10 metres further ahead (figure 30).



Figure 30: KRUZENSHTERN. Forward part of the main deck
Source: DMAIB

The master and the pilot on board KRUZENSHTERN were standing on the open bridge wing on the ship's starboard side when DIVER MASTER lost its manoeuvrability. The view from their position (figure 31) was obstructed by the rigging and it was difficult to get a clear view of the situation on board DIVER MASTER.



Figure 31: KRUZENSHTERN. View from manoeuvring stand on starboard bridge wing
Source: DMAIB

3.5 Planning of the towing operation and communication

KRUZENSHTERN was towed by means of a tug boat connected at each end of the ship. It was common practice to have the most powerful tug boat in the aftermost position in order to function as an emergency brake to slow down the towed ship if necessary. Therefore SVITZER HELIOS was attached to the stern end of KRUZENSHTERN as this was the superiorly powered tug.

The pilot on board KRUZENSHTERN ordered the tug boats into their respective positions and gave directions regarding their use of power during the towing operation. The pilot also advised on the rudder positions and engine manoeuvres to be carried out on board KRUZENSHTERN. The pilot coordinated the operation and communicated with each tug boat individually, which were therefore not in direct contact with each other.

The pilot, the tug masters and KRUZENSHTERN's master briefly agreed on a procedure prior to departure from Esbjerg.

4. ANALYSIS

4.1 The towing of KRUZENSHTERN

The accident occurred when DIVER MASTER assisted KRUZENSHTERN, as a forward tug boat, during departure from the Port of Esbjerg. KRUZENSHTERN was moving at the speed necessary for manoeuvring in the waters' strong current, and DIVER MASTER was overtaken when manoeuvring to the starboard side of KRUZENSHTERN as this continued ahead. In this situation, the engine power generated on board to control DIVER MASTER became ineffective, and the tug lost its manoeuvrability as it became subject to the dragging force of the water flow acting on the underwater hull (figure 32). In this situation, DIVER MASTER did not manage to realign with the towline and tow.

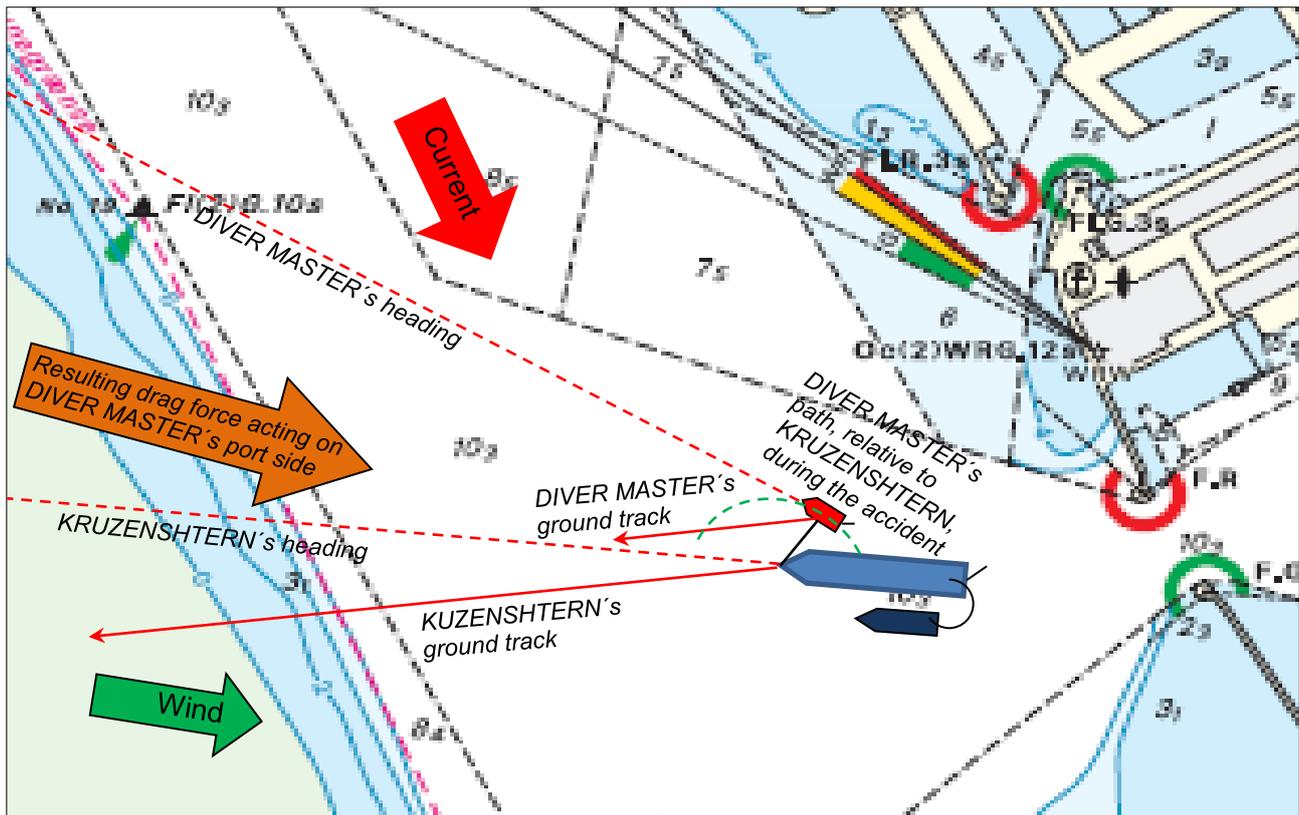


Figure 32: Situation showing DIVER MASTER being overtaken by its own tow
Source: DMAIB

The towing hook was not released when the crew made attempts at this, and the tug became subject to the girting phenomenon. DIVER MASTER capsized, became flooded and subsequently foundered outside the port entrance.

When DIVER MASTER was overtaken by its own tow, the towline was able to move freely until it left the ship's side close to amidships thus enhancing the susceptibility to girting. However, it is doubtful if the gog rope arrangement, if used to secure the towline, would have been able to withstand the drag forces induced on the tug's hull. With the gog rope arrangement in use the manoeuvrability of the tug would also have changed dramatically and it is uncertain how this would have changed the outcome of the accidental events.

DIVER MASTER had a low freeboard and therefore the deck edge was quickly immersed when the ship heeled excessively, causing an immediate loss of stability⁸. Water entered the hull through the open small hatch in the port side of the aft deck, and possibly other openings, causing a further significant reduction in the tug's stability. The entering water quickly flooded the stores room and the engine room, likely through the door between the stores room and the engine room.

The crewmembers on board DIVER MASTER and KRUZENSHTERN had very little time to respond to the events leading to the accidental consequences. From the moment when the crewmembers on board DIVER MASTER realized that they were losing control of the ship and communicated this to the pilot on board KRUZENSHTERN, and until DIVER MASTER capsized and water started entering, 40 seconds passed. Until KRUZENSHTERN's speed was reduced and the towing line was cut, another minute and 21 seconds passed. Less than five minutes later, DIVER MASTER had foundered. The crewmembers, the master and the pilot on board KRUZENSHTERN were in a bad position to observe the situation develop on board DIVER MASTER and take any preventive actions beforehand.

When the master of DIVER MASTER realized that he was losing control of the tug, he was in a starboard turn and his focus was on the release of the towline from the towing hook, to remedy the situation. Turning starboard may well have been the intuitive response to try to realign DIVER MASTER with the towline. However, this manoeuvre increased the initial heeling to port, induced by the dragging force on the hull. When the attempt to release the towline from the hook failed, the short timeframe did not allow alternative measures.

The towing hook quick-release function did not work as expected. It is likely that the hook did not release due to a combination of the larger dimensions of the towline supplied by KRUZENSHTERN and the immense tension it induced on the hook. The latter is likely to have been well above the towing hook's nominal working and testing parameters.

All those on board DIVER MASTER managed to take up a position where they could be picked up and transferred to the rescue boats on site. Escape from the wheelhouse was most likely possible only because DIVER MASTER capsized onto its port side.

4.2 The decision to use DIVER MASTER

The decision to use DIVER MASTER as a substitute for the larger and more powerful SVITZER TRYM, which had initially been ordered for the towing of KRUZENSHTERN, was influenced by the time pressure induced by the decision to close the port for the fireworks show.

With the knowledge of the circumstances that prevailed prior to the towing operation, all parties agreed that using DIVER MASTER as a substitute was a fair and acceptable option in a situation constrained by uncertainty about the availability of SVITZER TRYM and by the required departure of KRUZENSHTERN prior to closing the port. Nothing indicated that a deviation from the original plan would be an unfavourable decision, or that DIVER MASTER was not suitable for the job. The latter is further substantiated by the decision not to use SVITZER TRYM though this turned out to be available on time after all.

BB Towing & Diving had an incentive to accept the assignment of towing KRUZENSHTERN during departure. The job was requested by the Port of Esbjerg, which accounted for a major part of the company's business base. DIVER MASTER was available for the job and the company naturally wanted to deliver a good service and to display a willingness to help and care for its customers. With the conception of what was expected of DIVER MASTER on this particular job, nothing indi-

⁸ When the deck edge becomes immersed, the breadth of the water plane will decrease and this will manifest itself in the GZ curve by a reduction in the rate of increase of the GZs with increase in heel.

cated that it was unfavourable to accept it. Therefore, DIVER MASTER was quickly mobilized for the sudden towing job.

The master of DIVER MASTER may have had an idea of what the marine community in Esbjerg, which he was familiar with and vice versa, would expect of the capabilities of his tug boat. This may have led to the assumption that he would be let off before exiting the port with KRUZENSHTERN, as he himself did not consider DIVER MASTER suitable for towing such a large vessel in an area with strong currents, because of its size and features.

4.3 The master's qualifications

The master of DIVER MASTER had been the owner of the ship since 1995. Since then, DIVER MASTER had been trading in and around the Port of Esbjerg. The master did not have the required formal qualification as "*Master home trade*" to be the master of the ship. Neither did he have any exemption to authorize his position as master on board DIVER MASTER.

The training plan for the Master's home trade examination did not include elements which addressed towing operations specifically. The girting phenomenon is known from other accidents where the formal qualifications of the crew members were adequate. Furthermore the master of DIVER MASTER was experienced in operating the ship. Therefore, a direct causality between the foundering of DIVER MASTER and the master's inadequate formal maritime qualifications could not be substantiated. However, it indicated that there was no professionalized organizing of the ship board operations on DIVER MASTER.

5. CONCLUSIONS

DIVER MASTER was requested as a substitute for the larger SVITZER TRYM. The parties involved in the towing operation considered this an unproblematic and convenient solution in a situation which was influenced by time constraints due to KRUZENSHTERN's need to depart Esbjerg before the port was closed.

As DIVER MASTER manoeuvred into a position where it was overtaken by its own tow, it was left in a critical situation. Control of the tug was lost and the girting phenomenon occurred. This led to the capsizing, flooding through deck openings, and subsequent foundering of DIVER MASTER.

The period of time covering the events leading up to the accident left only limited time to respond to the situation. Moreover, during the unfolding events, options for mitigating the critical situation were not obvious to the master of DIVER MASTER. The circumstances inevitably meant that the knowledge of the overall situation and its final outcome held by the crewmembers on board both DIVER MASTER and KRUZENSHTERN was limited as the events unfolded.

Girting is a phenomenon known to have occurred during various other towing scenarios. Therefore the difference in size between DIVER MASTER and KRUZENSHTERN cannot be considered the single determining factor during these accidental events. It was, however, decisive for the outcome that the critical situation could not be mitigated by releasing the towing hook. When attempts to release the towing hook failed, the crewmembers on board DIVER MASTER did not have any more time to pursue other options before the consequences became inevitable.

The master of DIVER MASTER was not formally qualified for his position. A direct causality between the missing qualification and the accident has not been established by the DMAIB. However an indirect connection was found as the missing qualification indicated that there was no professionalized organizing of ship board operations.

DIVER MASTER was subsequently salvaged. However, the ship had suffered substantial damage and therefore it is no longer in service. BB Towing & Diving is no longer owned by the master who was involved in the accident.