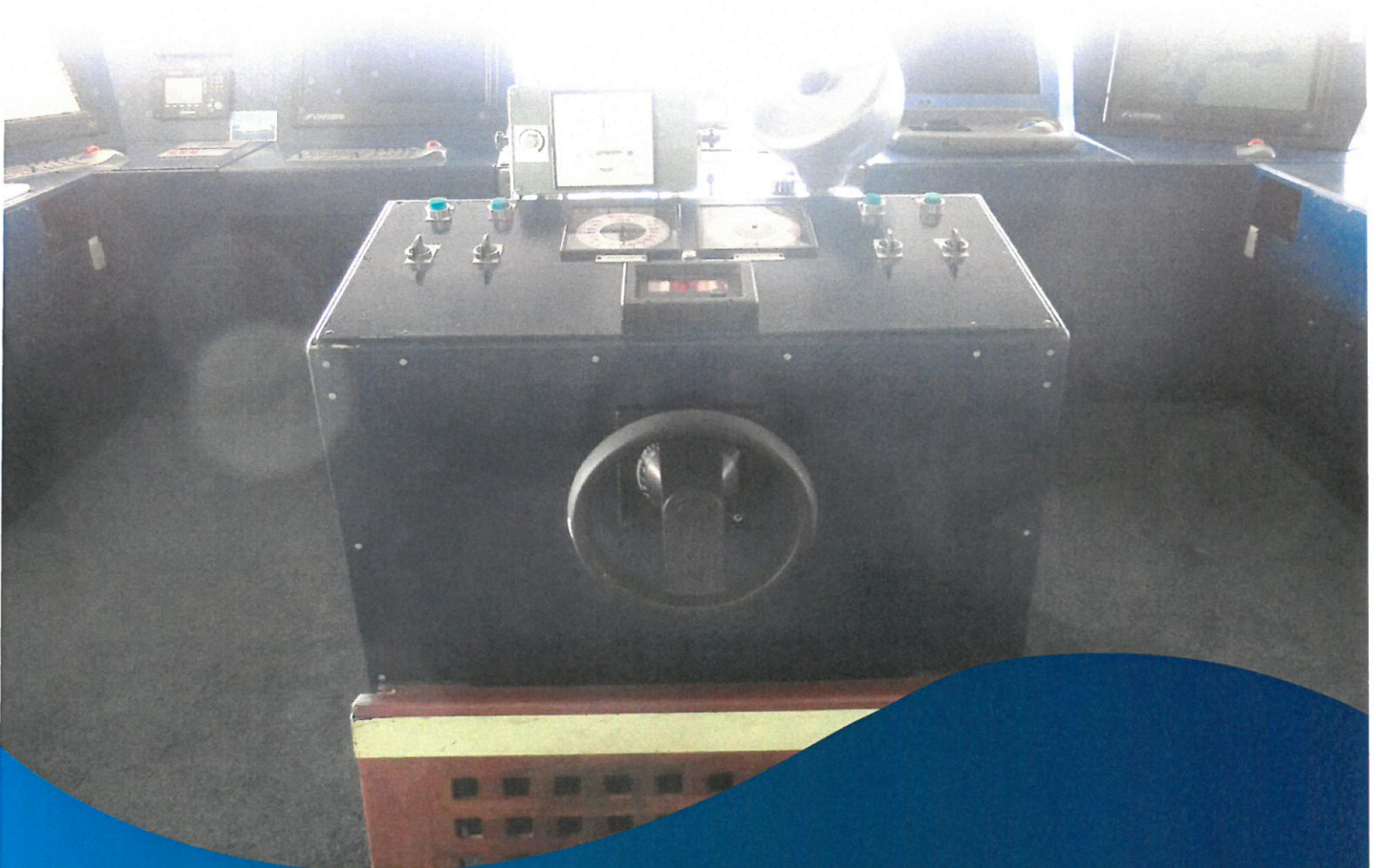




Danish Maritime Accident
Investigation Board

MARINE ACCIDENT REPORT

February 2015



STENA NAUTICA
Allision on 8 July 2014

The Danish Maritime Accident Investigation Board
Carl Jacobsens Vej 29
DK-2500 Valby
Denmark
Tel. +45 91 37 63 00

E-mail: dmaib@dmaib.dk
Website: www.dmaib.com

Outside office hours, the Danish Maritime Accident Investigation Board can be reached on +45 23 34 23 01.

This marine accident report is issued on 13 February 2015

Front page: Centre steering console on STENA NAUTICA Source: DMAIB

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.

Contents

1. SUMMARY	4
2. FACTUAL INFORMATION	4
2.1 Photo of the ship.....	4
2.2 Ship particulars.....	4
2.3 Voyage particulars.....	5
2.4 Weather data.....	5
2.5 Marine casualty or incident information.....	5
2.6 Shore authority involvement and emergency response.....	5
2.7 The ship's crew.....	6
2.8 Scene of the accident	7
3. NARRATIVE	7
3.1 Background	7
3.2 Sequence of events – Bridge.....	7
3.3 Sequence of events – Engine room	10
3.4 Details of steering system.....	14
3.5 Damage.....	17
4. ANALYSIS.....	17
5. CONCLUSIONS	18
6. PREVENTIVE MEASURES TAKEN	19

1. SUMMARY

On 7 July 2014 at 2340, the Swedish ro-ro passenger ship STENA NAUTICA departed Grenaa Port, Denmark bound for Varberg, Sweden on its regular route. On board were 155 passengers and 55 crewmembers as well as a number of vehicles. At midnight, just as the ship was ready to pass the outer breakwater, the ship suddenly and unintendedly turned hard to starboard and hit the breakwater resulting in substantial hull indentations and penetrations below the waterline, leading to substantial flooding of the engine rooms. The ship immediately returned to berth where all passengers were evacuated and all cargo discharged. Subsequently, after carrying out preliminary repairs, the ship proceeded to Fayard in Munkebo, Denmark for damage assessment and repair. No passengers or crewmembers were injured during the incident.

This report focuses on the issues of the bridge layout and the design and operation of the steering systems. The accident has led to preventive measures taken by the company (see section 6).

2. FACTUAL INFORMATION

2.1 Photo of the ship



Figure 1: STENA NAUTICA
Source: Wikipedia.org / Public domain

2.2 Ship particulars

Name of vessel:	STENA NAUTICA
Type of vessel:	Ro-ro passenger ship
Nationality/flag:	Sweden
Port of registry:	Göteborg
IMO number:	8317954
Call sign:	SGQU
DOC company:	Stena Line Scandinavia AB

IMO company no. (DOC):	1249369
Year built:	1986
Shipyard/yard number:	A/S Nakskov Skibsværft/#234
Classification society:	Lloyd's Register
Length overall:	135.46 m
Breadth overall:	24.62 m
Gross tonnage:	19,504
Deadweight:	3,676 t
Draught max.:	5.84 m
Engine rating:	12,480 kW
Service speed:	18.5 knots
Hull material:	Steel
Hull design:	Single hull

2.3 Voyage particulars

Port of departure:	Grenaa, Denmark
Port of call:	Varberg, Sweden
Type of voyage:	Merchant shipping, international
Cargo information:	Passengers, vehicles
Manning:	55
Pilot on board:	No
Number of passengers:	155

2.4 Weather data

Wind – direction and speed:	North 7-9 m/s
Wave height:	Smooth
Visibility:	Good
Light/dark:	Dark
Current:	Unknown

2.5 Marine casualty or incident information

Type of marine casualty/incident:	Casualty to ship
IMO classification:	Serious
Date, time:	8 July 2014 at 0000 LMT
Location:	Port of Grenaa, Denmark
Position:	56°25.0' N – 010°56.2' E
Ship's operation, voyage segment:	Departure/Manoeuvring
Place on board:	Engine rooms, steering gear room, void spaces
Human factor data:	Yes
Consequences:	Damage to hull structure, equipment and cables. Flooding of engine rooms, steering gear room, void tanks

2.6 Shore authority involvement and emergency response

Involved parties:	Police, port authorities, Danish Emergency Management Agency (DEMA), diving/salvage Company
Resources used:	Pumping assistance from DEMA

Actions taken: Containment of water ingress, emergency discharge from flooded compartments.
Results achieved: Ship stayed afloat, all passengers evacuated, no injuries.

2.7 The ship's crew

Master: 30 years at sea. Had served with the company for 19 years and had served as master on STENA NAUTICA for 17 months.

2nd officer/1: 12 years at sea. Had served with the company for 9 years, 1½ of which on STENA NAUTICA.

2nd officer/2: 12 years at sea. Had served with the company for 10 years, all of which on STENA NAUTICA.

Helmsman: 3 years at sea. Had served with the company for 2 years, 1½ of which on STENA NAUTICA.

Chief engineer: 30 years at sea. Had served with the company for 13½ years, 4½ of which as chief engineer on STENA NAUTICA.

2nd engineer: 9 years at sea. Had served with the company for one year, 6 months of which as a 2nd engineer on STENA NAUTICA.

Motorman: 11 years at sea. Had served with the company for 8 years, all of which on STENA NAUTICA.

2.8 Scene of the accident

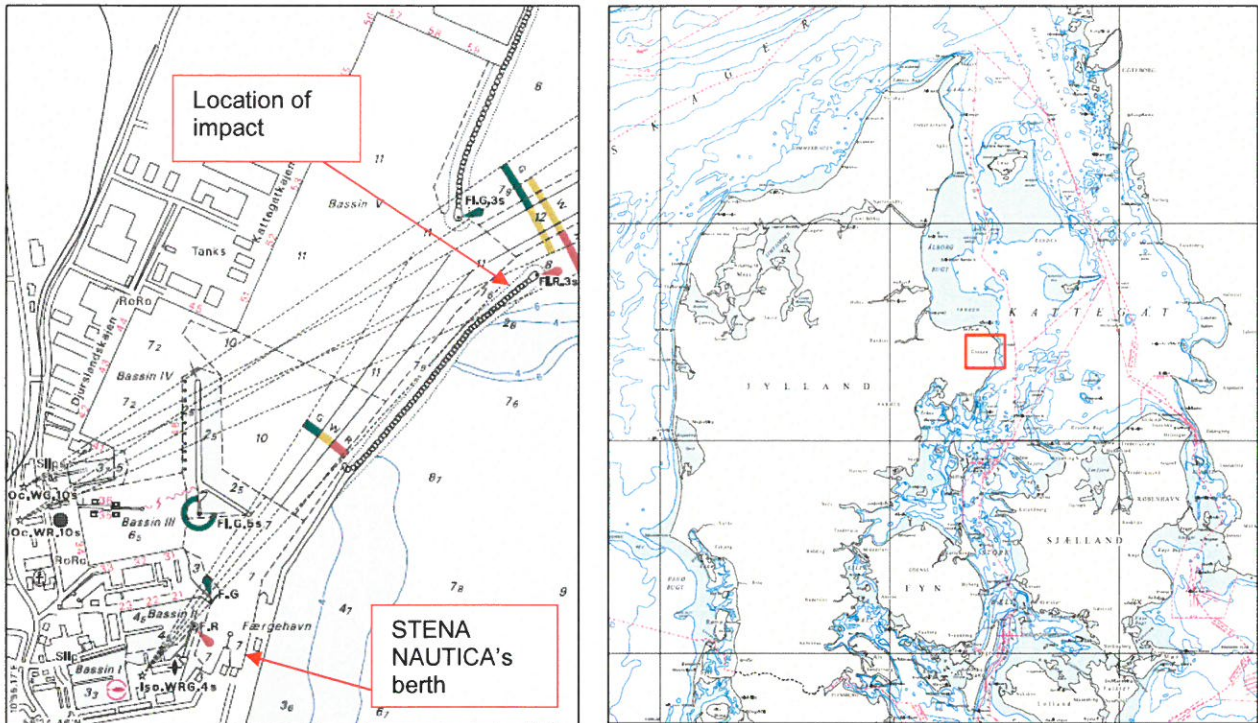


Figure 2: Scene of the accident, Port of Grenaa, Denmark
Source: Danish Geodata Agency

3. NARRATIVE

3.1 Background

STENA NAUTICA was a ro-ro passenger vessel with a capacity of 900 passengers and 312 cars (1247 lane metres). At the time of the accident the ship was owned and operated by Stena AB and was deployed on the Stena Line route between Grenaa in Denmark and Varberg in Sweden.

STENA NAUTICA usually made two round trips per day, with a crossing time of 4¼ to 5½ hours. The scheduled arrival time at Grenaa was 2250 and departure was scheduled for 2350, leaving a turnaround time of one hour for unloading and loading of passengers, vehicles and cargo. In Grenaa, STENA NAUTICA berthed in the ferry harbour, in Basin III. The ship berthed bow first and loaded and unloaded through two bow ramps on decks 3 and 5, respectively.

The ship was equipped with two main engines driving two individual controllable pitch propellers. In addition there were two bow thrusters and one stern thruster. The bridge layout consisted of a centre control station, including a steering console, and a bridge wing steering console in each side (figure 3).

All times in this report are the ship's local time (UTC+2).

3.2 Sequence of events – Bridge

On the night of 7 July 2014 at 2340, when STENA NAUTICA departed the berth in Grenaa two crewmembers were present on the bridge: the master and one 2nd officer. The master was in command, manning the port side bridge wing control station from where he controlled the main engines, the rudders and bow propellers (figures 3 and 4).

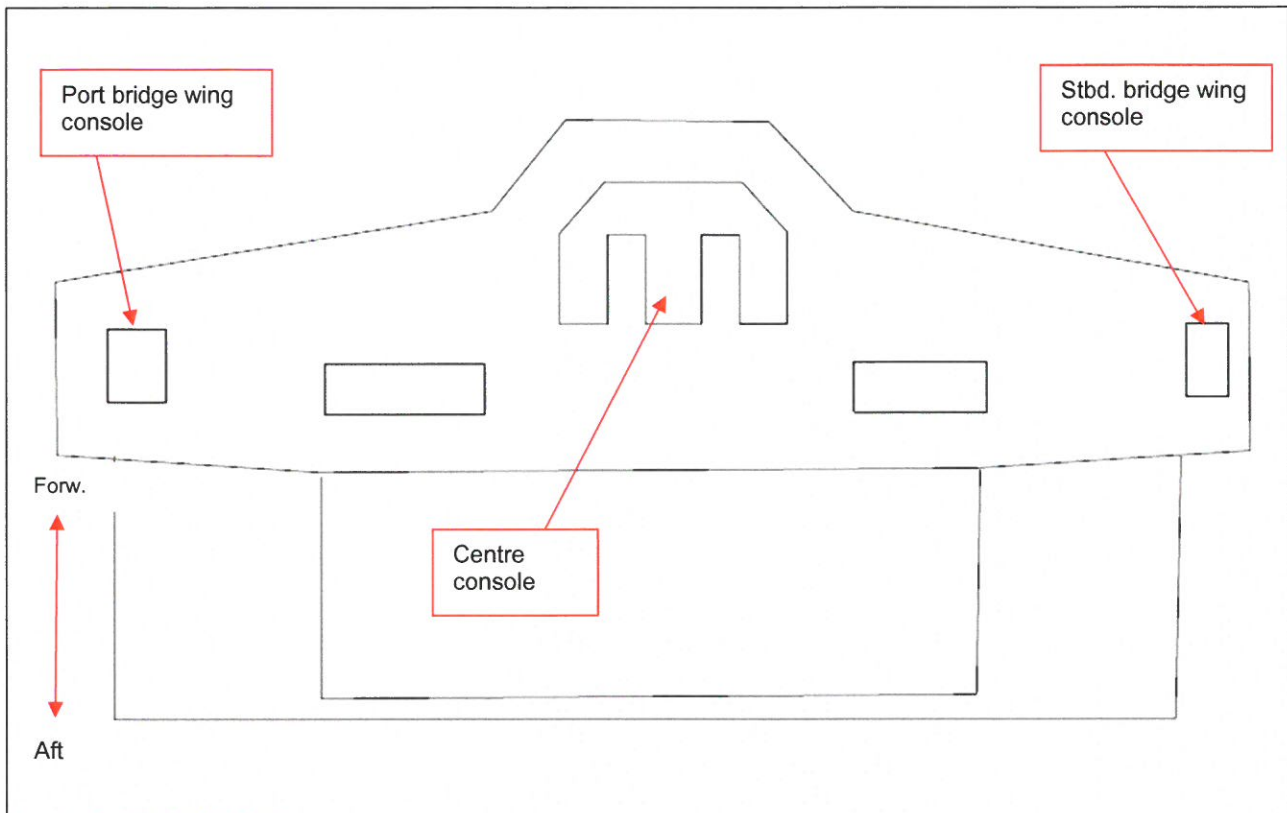


Figure 3: Outline of STENA NAUTICA's bridge. Approx. locations of steering consoles indicated.
Source: DMAIB



Figure 4: Port and centre steering consoles.
Source: DMAIB

As per normal procedure, the ship manoeuvred by the stern out of the berth and proceeded to perform a turning manoeuvre in the outer basin (figure 5). During the turn, the other 2nd officer and a helmsman came to the bridge and positioned themselves near the centre console.

The turn was completed when the ship's heading was 051°, which was the intended course leading out of the harbour. Simultaneously, the master ordered "Fuel 50" to be entered into the ship's ETA Pilot¹, meaning that the ETA Pilot would take over control of the acceleration/engine revolutions.

¹ ETA Pilot is an electronic device that optimizes settings for fuel consumption, engine revolutions, propeller pitch, etc. The 'Fuel 50' setting means that the main engines consume 50 litres of fuel per nautical mile.

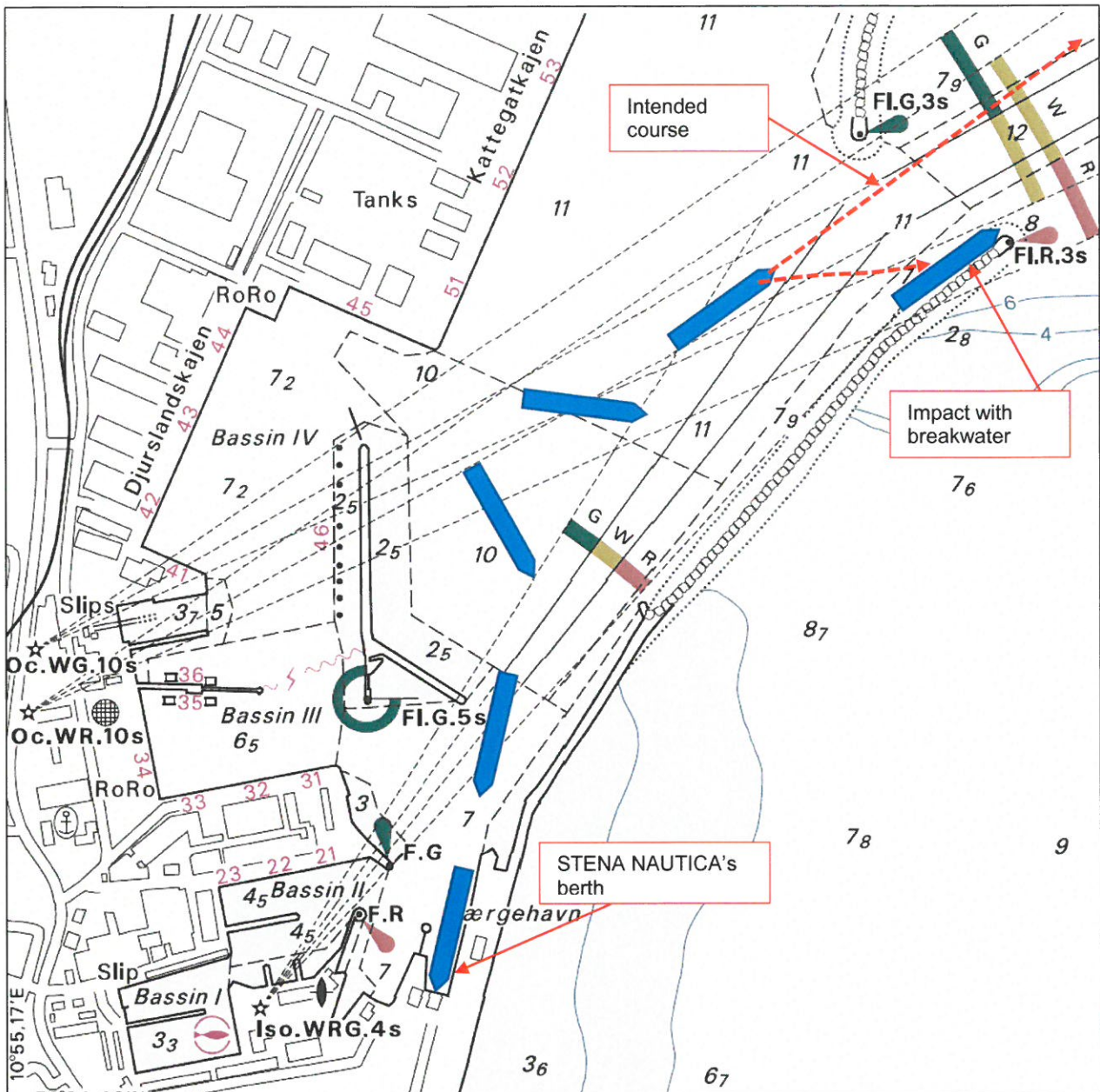


Figure 5: Port of Grenaa. STENA NAUTICA's berth and tum manoeuver sketched
 Source: Danish Maritime Authority/Danish Geodata Agency

When the ship was approximately 50-100 metres from the end of the outer southern breakwater, the master ordered the steering transferred to the centre console (figure 5), which also meant that the steering was switched to manual steering by the helmsman. As per normal practice, the master ordered the helmsman to take over on course 051.

The normal procedure for switching over steering from bridge wings to hand steering at the centre console varied. Some officers and helmsmen agreed that the helmsmen themselves would operate the steering mode switches, while others preferred that the officer on watch was in charge of the operation. On the day of the accident, the helmsman and 2nd officer on watch agreed that the officer would operate the switch.

The 2nd officer confirmed the takeover, pressed the *TAKE OVER* button, and the helmsman confirmed hand steering. However, immediately after, the helmsman expressed doubt as to whether he had hand steering as he felt the ship did not react to the helm as he expected.

Shortly after, the master noticed that the ship was still turning to starboard and ordered rudder to port. At this point, the helmsman again expressed doubts as to whether hand steering from the centre console was active as he felt no reaction from the ship when he gave port helm. The 2nd officer turned on the lamp over the control panel and pressed the takeover button again to ensure that steering from the centre console was active.

As the ship continued turning to starboard, the master realized that the ship was about to collide with the breakwater. He rushed to the centre console and turned the switch to the *FU Helm direct* position. *Follow up helm* means that the manoeuvres made at the helm bypass the steering computers and go directly to the steering gear, thus avoiding potential computer errors.

The master then pushed the *TAKE OVER* button again to ensure that the steering was at the centre console, and repeated the order “hard to port” in order to soften the anticipated impact with the breakwater. The helmsman still felt no reaction from the ship. The master then returned to the port bridge wing and took over the steering from there. He also deployed one of the bow thrusters and the stern thruster and finally managed to stop the ship’s starboard turn. However, by then the ship was too close to the breakwater to avoid contact.

The first impact with the breakwater occurred at approx. 0000, followed by another, heavier impact shortly after. These events, from the time the bridge crew realized something was wrong until the impact, happened within a time span of a few minutes.

Immediately after the impact, the master decided to return to the berth. The ship was turned just outside the outer breakwaters. The master announced over the public address system that the ship was experiencing technical problems. In the period from the impact until the ship was berthed, the bridge and engine crew were in frequent contact, discussing consequences and options as the situation developed.

At 0017, the ship was berthed. At 0030, the general alarm was sounded and the master informed the passengers that the ship had grounded and that all passengers should muster in the coffee shop area for disembarkation. Simultaneously, the chief officer alerted the company’s emergency response team and called the harbour authorities, requesting them to alert the local fire brigade and a diving company. The passenger muster was complete at 0055, and at 0230 all cargo had been discharged and all passengers and vehicles had disembarked the ship.

3.3 Sequence of events – Engine room

During the departure from Grenaa, the engine control room was manned by the chief engineer, a second engineer, a cadet and a motorman.

Figure 6 below shows a plan of the engine room layout seen from above tank top level. The sections of the engine room, auxiliary engine room, main engine room, shaft generator room and sewage room are separated by watertight bulkheads and doors. At sea, the watertight doors are generally closed, and are opened only to allow passage.

At 0002, the engine crew reported to the bridge that they had felt the impact and shortly after there was a bilge alarm from Dry Tank 6. The 176 m³ tank flooded immediately.

In accordance with the ship’s emergency procedures for grounding, the motorman commenced sounding by hand of all tanks on the starboard side. When the motorman lifted the cap on the sounding pipe to Dry Tank 6, the water gushed straight up to the deck above. Soon after, when he opened the watertight door to the shaft generator room, he saw water gushing into the room from the area around the starboard stabilizer and reported to the engine control room that the ship had a leak near frame 85.

At approximately 0006, several alarms sounded, indicating low temperatures on the starboard main engine lube oil system, leading the chief engineer to suspect that sea water had leaked into the lube oil sump. He informed the master of this and it was decided to shut down the main engine in order not to damage it. At the same time, at approximately 0015, the heavy fuel supply was shut off and the remaining engines continued to run on diesel oil.

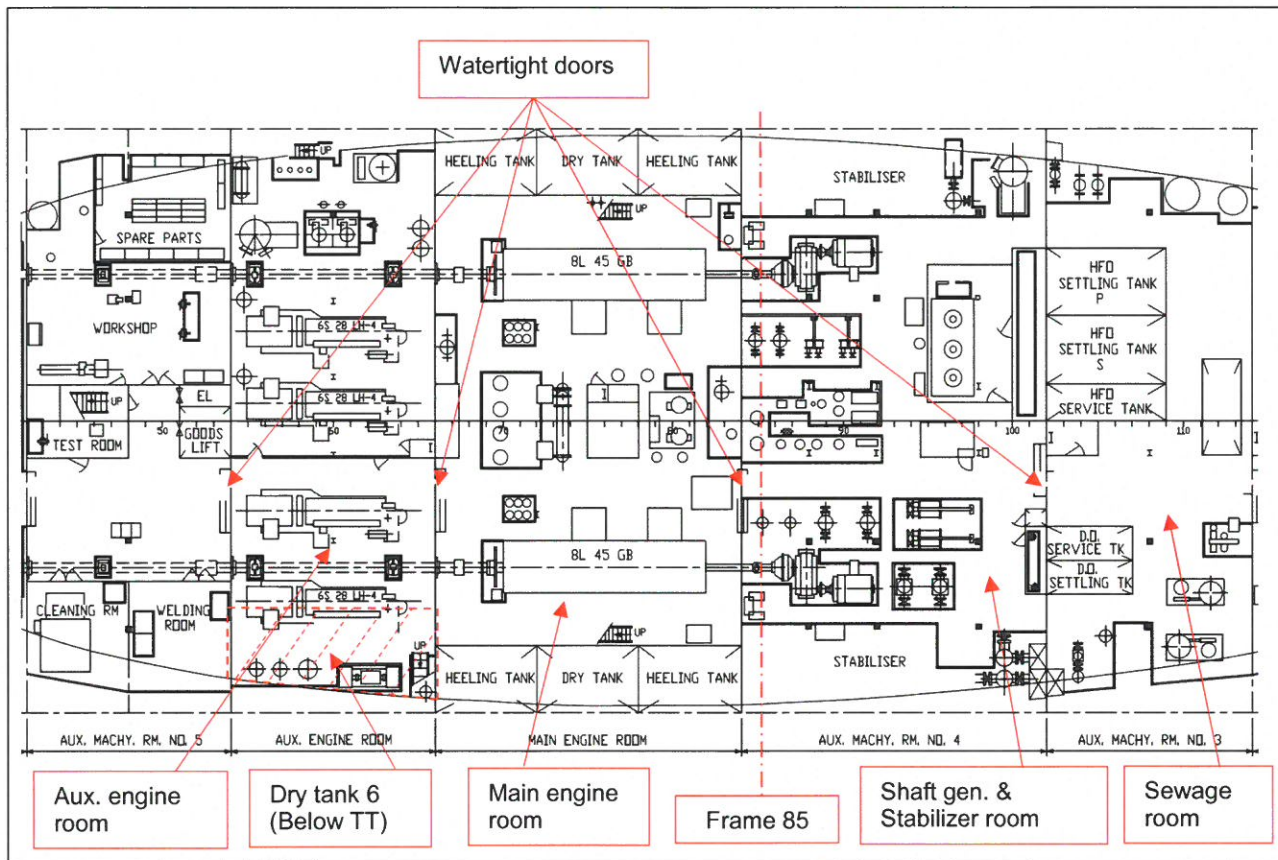


Figure 6: Excerpt of engine room layout. Deck 1 (Tank top level, viewed from above).
Source: Stena Line AB

From the control room all available engine crew were called to report for duty. Two crewmembers were sent to the area in the shaft generator room to assess whether any efforts could be made to contain the water ingress by blocking the leak. Due to the large ingress this was not possible.

At the same time, at around 0020, the bilge pumps were started but these could not keep up with the amount of water leaking into the room. Because they were located in the main engine room, it was not possible to deploy direct suction by the largest seawater pumps; the emergency bilge suction. The shaft generator room was quickly flooded up to tank top level. Because the shaft generator room also contained other vital equipment, such as fuel supply pumps, booster units, fuel oil separators, HT and LT cooling pumps, it was decided to close the watertight doors to the room to prevent flooding of the main engine room. The water level in the shaft generator room kept rising and soon reached the level of the electrical motors, approximately one metre above tank top level. Eventually, the room was flooded up to approximately 0.5 metres below the deck above (figures 7 and 8).

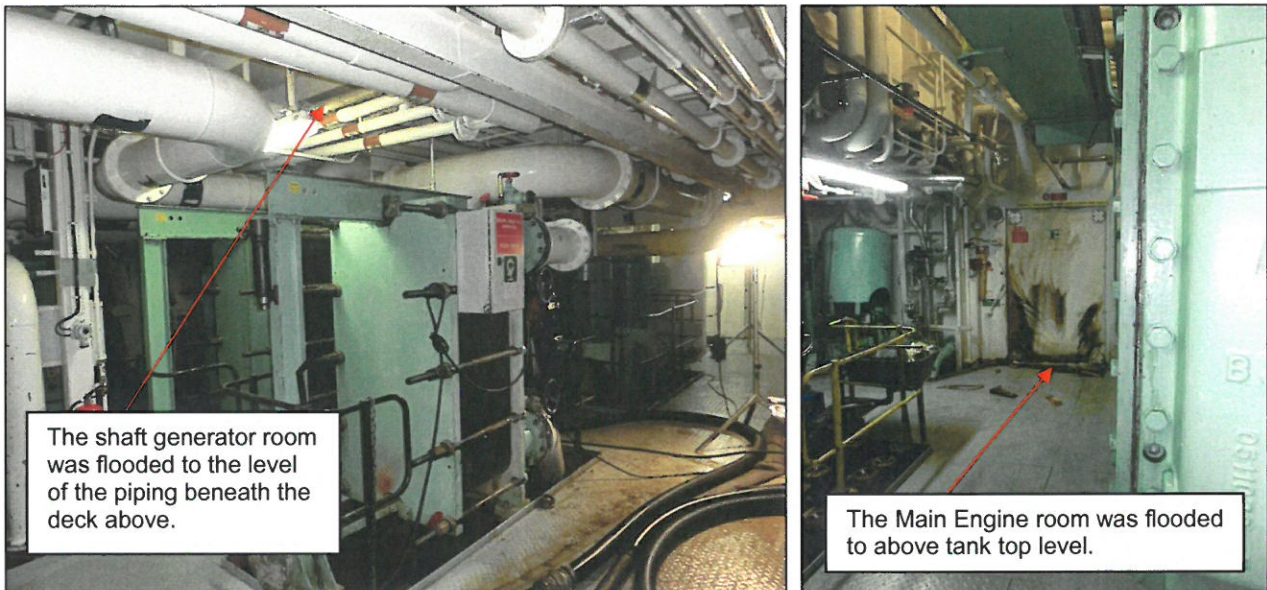


Figure 7: Left: Shaft generator room. Right: Main engine room. Approximate water levels indicated.
Source: DMAIB

Although the watertight doors had been closed, sea water leaked into the main engine room and the sewage room, located just aft and forward of the shaft generator room, respectively. The engine crew observed water ingress through the watertight doors, and the water level in the adjoining rooms eventually rose until it reached about 10 cm above tank top level at approximately 0217.

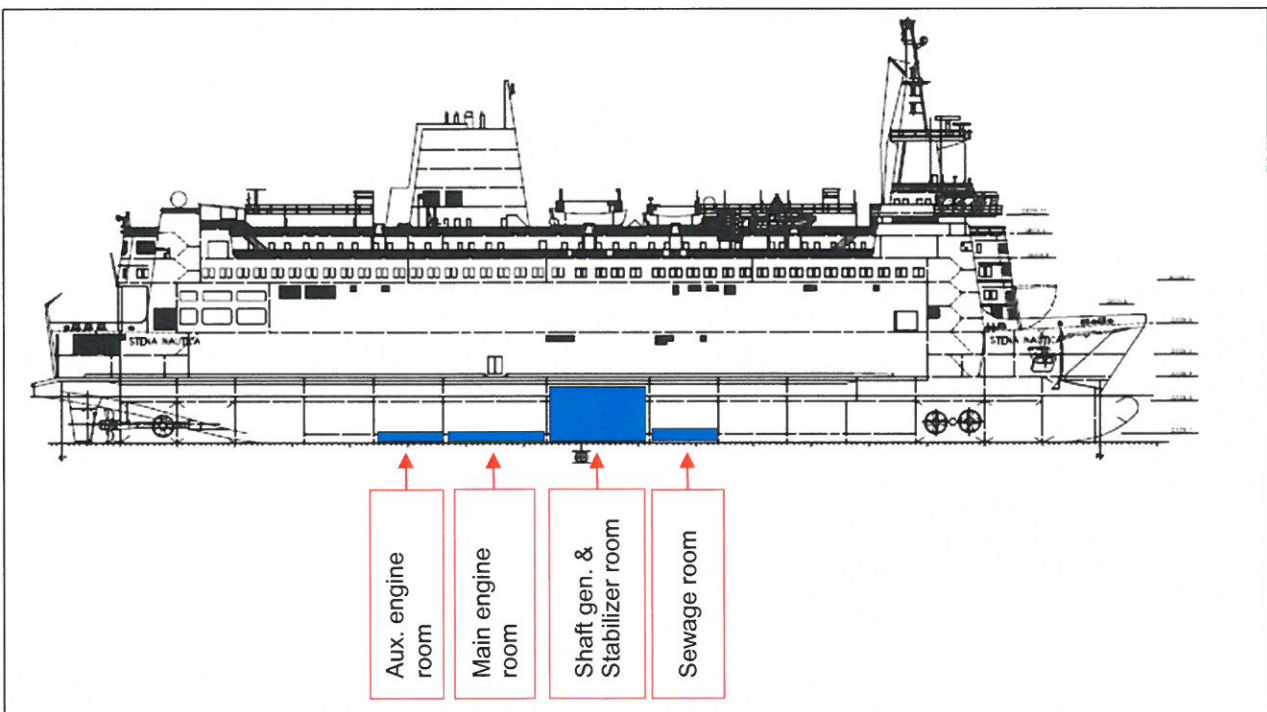


Figure 8: Side view of STENA NAUTICA. Approximate flooding levels in engine rooms indicated.
Source: STENA AB / DMAIB

At 0228, it was decided to perform a controlled black-out, as the water had reached the electrical motors and auxiliary engine no. 1 had shut down. The remaining auxiliary engine (no. 4) was manually shut down at 0230, along with its supply systems, and at 0231, the black-out was commenced. At the same time the emergency generator was started.

At 0145, as the emergency bilge discharge from the flooded rooms was commenced, the ship's FRB (Fast Rescue Boat) was launched and attempts were made to place a tarpaulin on the outside hull in the area of the damage to limit the water ingress. At 0230, the tarpaulin was in position, secured with magnets.

At 0210, the local fire brigade came on board.

At 0315, salvage divers came on board, and at 0400 they entered the water to assess the damage. At around 0420, the divers reported that the ship had a hull penetration stretching from frame 70 to frame 85, approx. 180 mm in height.

At 0430, the Danish Emergency Management Agency (DEMA) came on board, requested by the fire brigade, to assist with damage control and discharge efforts. At the same time, the ship's insurance representatives attended.

Between 0615 and 0630, submersible pumps, provided by the fire brigade and DEMA, were deployed in the shaft generator room and in the sewage room.

Emergency repairs were carried out and eventually the leaks were stopped. During the following hours and days, the flooded compartments were emptied and the ship was made seaworthy for the voyage to a shipyard.

3.4 Details of steering system

Figures 9 and 10 below show overviews of STENA NAUTICA's centre steering console and the port bridge wing console. Various parts of the steering system are indicated on the photo and dealt with in detail in the following sections.

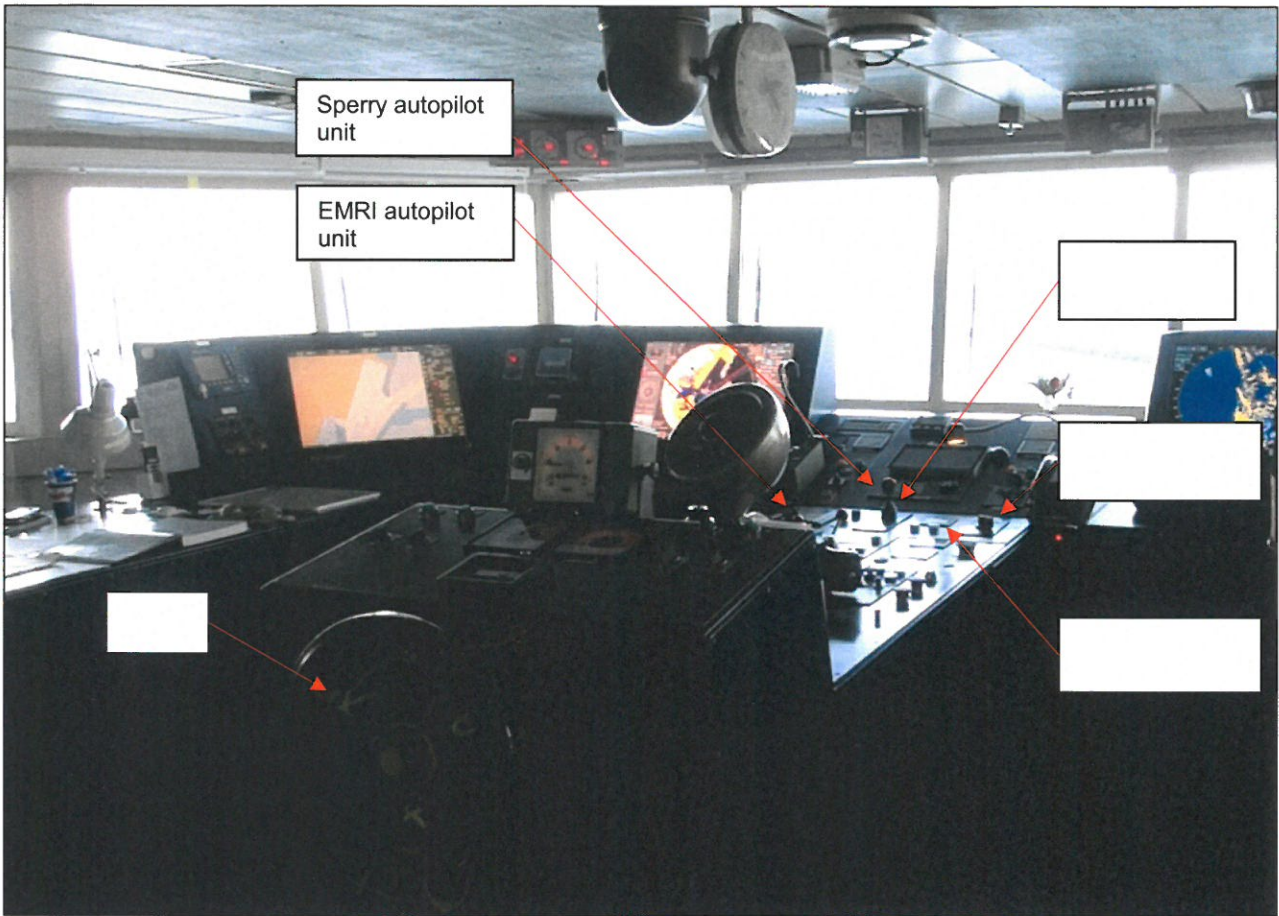


Figure 9: Overview of centre console. Elements of steering system indicated.
Source: DMAIB

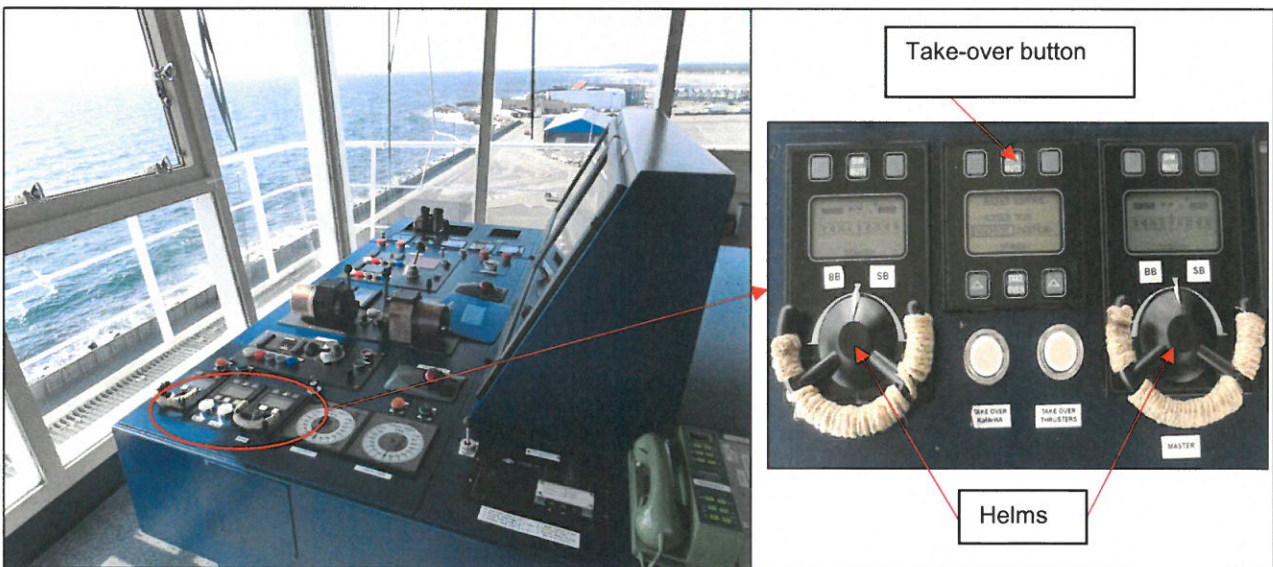


Figure 10: Port bridge wing console.
Source: DMAIB

Following a refit in 2013, STENA NAUTICA was fitted with new steering systems as sketched below (figure 11). As a part of the refit, a Sperry Navipilot 4000 autopilot unit was fitted, while the original EMRI autopilot unit was retained for backup purposes.

The new Sperry autopilot panel was placed on the forward part of the centre console, just above the override tiller. The override is used for immediate manoeuvring and the rudders will respond instantly when the tiller is activated, regardless of all other settings. Some officers preferred using the original EMRI unit for autopilot steering, partly because they felt the position of the Sperry unit posed a risk of unintentionally activating the override tiller, partly because the user interface of the EMRI unit was considered more user friendly than the Sperry unit's.

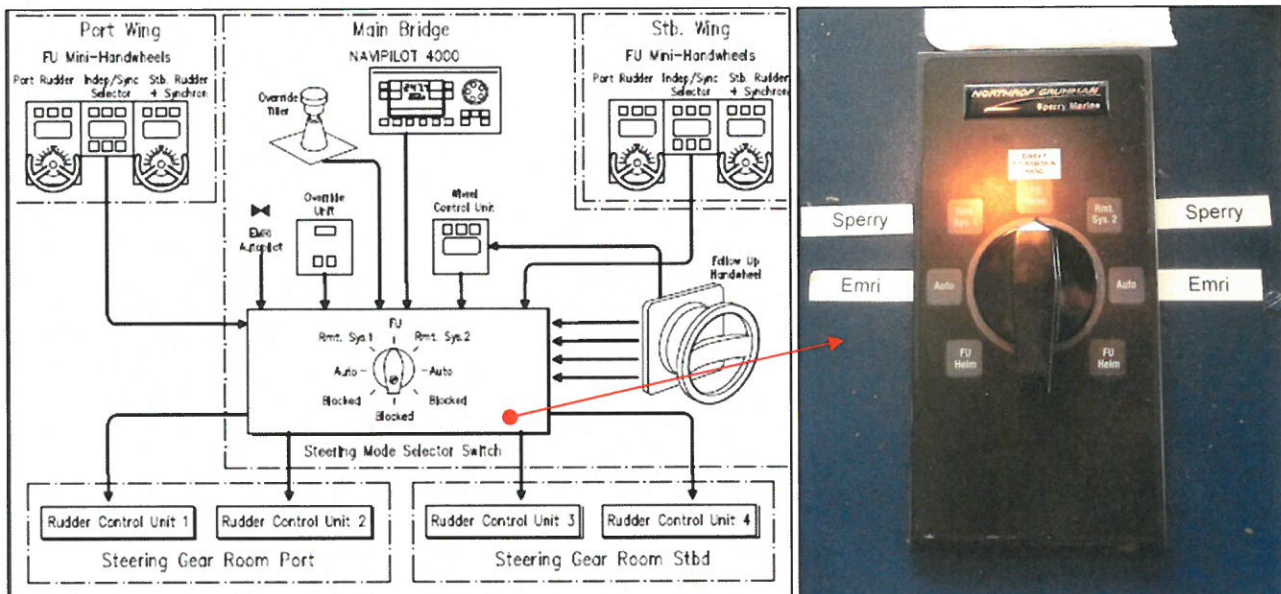


Figure 11: Left: Diagram of steering setup. Right: Steering mode selector switch on the bridge of STENA NAUTICA. Source: STENA AB/DMAIB

The combined steering mode selector switch for the Sperry and EMRI systems had five active settings: The *Rmt. Sys. 1 & 2* settings allowed steering by the Sperry autopilot and both bridge wing consoles. The two settings marked *Auto* allowed steering by the EMRI autopilot, and the top setting, *FU Helm*, was for helm steering. The control of steering was switched to the centre and bridge wing consoles, respectively, by pressing the *TAKE OVER* buttons located on the consoles (figures 12 and 10). In addition, there was an override unit controlled by a tiller (joystick) which was ready for immediate action, without operating other switches or buttons.

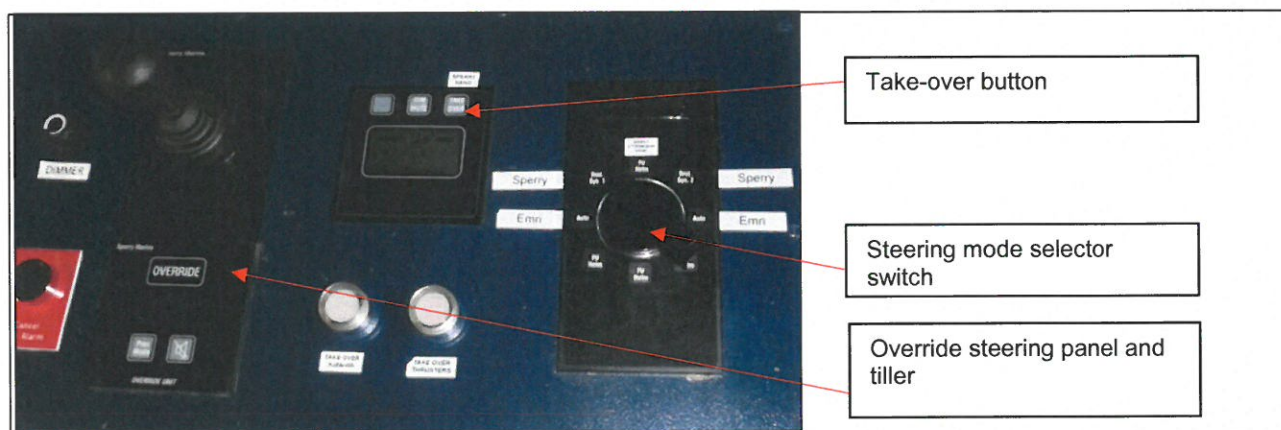


Figure 12: Detail of centre steering console. Source: DMAIB

As a part of the installation of the new steering system, the helm had been replaced with a new one which was smaller than the original one. It was designed with a turn indicator placed on the helm itself. The helm was not fitted with a counterweight or spring which meant that the helm would stay in the position to which it was turned. There were no mechanical or procedural features that could ensure that the helm was in neutral when hand steering was used. Although back lighting was fitted, it was difficult to visually establish the actual position of the helm, especially at night (figure 13).

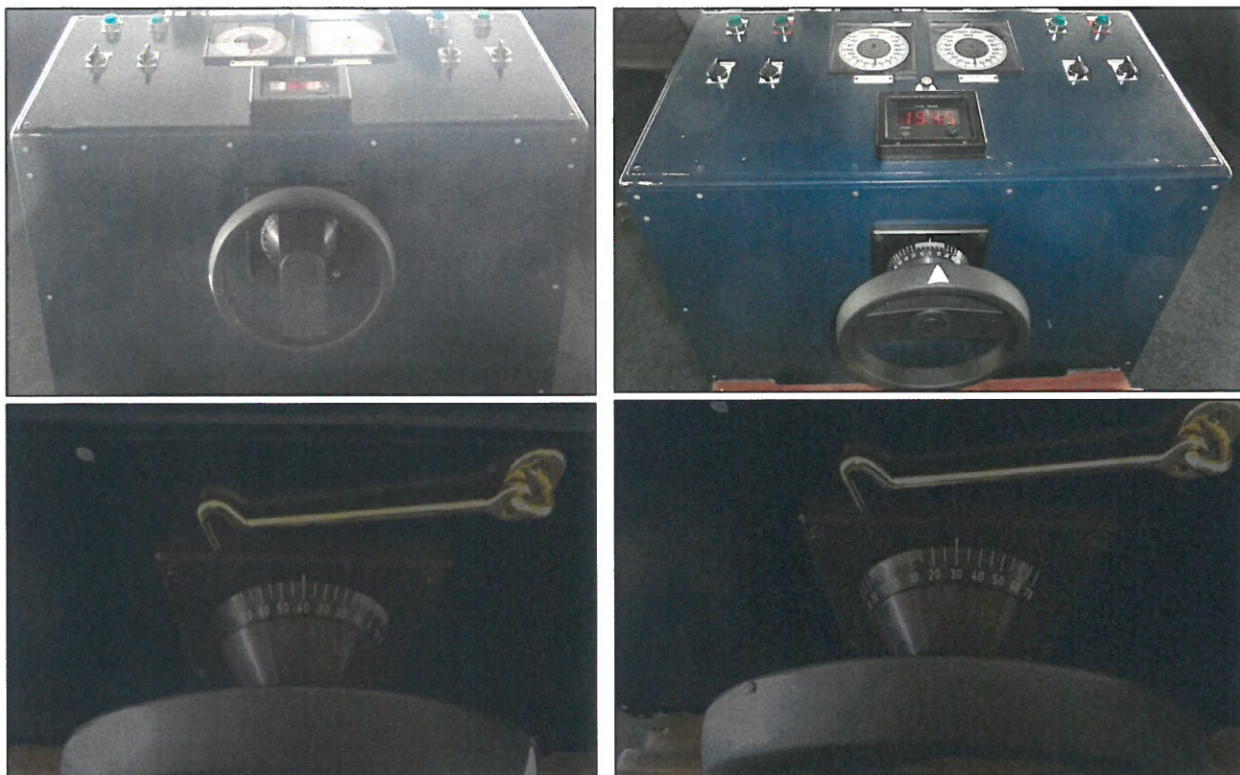


Figure 13: Hand steering wheel. Top left: Hard to port. Top right: Neutral/centered. Bottom left: Hard starboard. Bottom right: Hard port.(Brass hook fitted after the accident).
Source: DMAIB

3.5 Damage

After a few days berthed in Grenaa, STENA NAUTICA relocated to Fayard Ship Repair Yard for damage assessment and repairs.

Subsequent examination of the steering systems revealed no technical errors in the system, which appeared to work as intended. The company decided to implement physical and procedural changes to avoid future incidents.

The ship had suffered substantial damage to machinery, including both shaft generators and their gears, high and low temperature systems, fuel plant, stabilizer controlling units, electrical installations in general, propeller blades and the hull structure (figure 14).

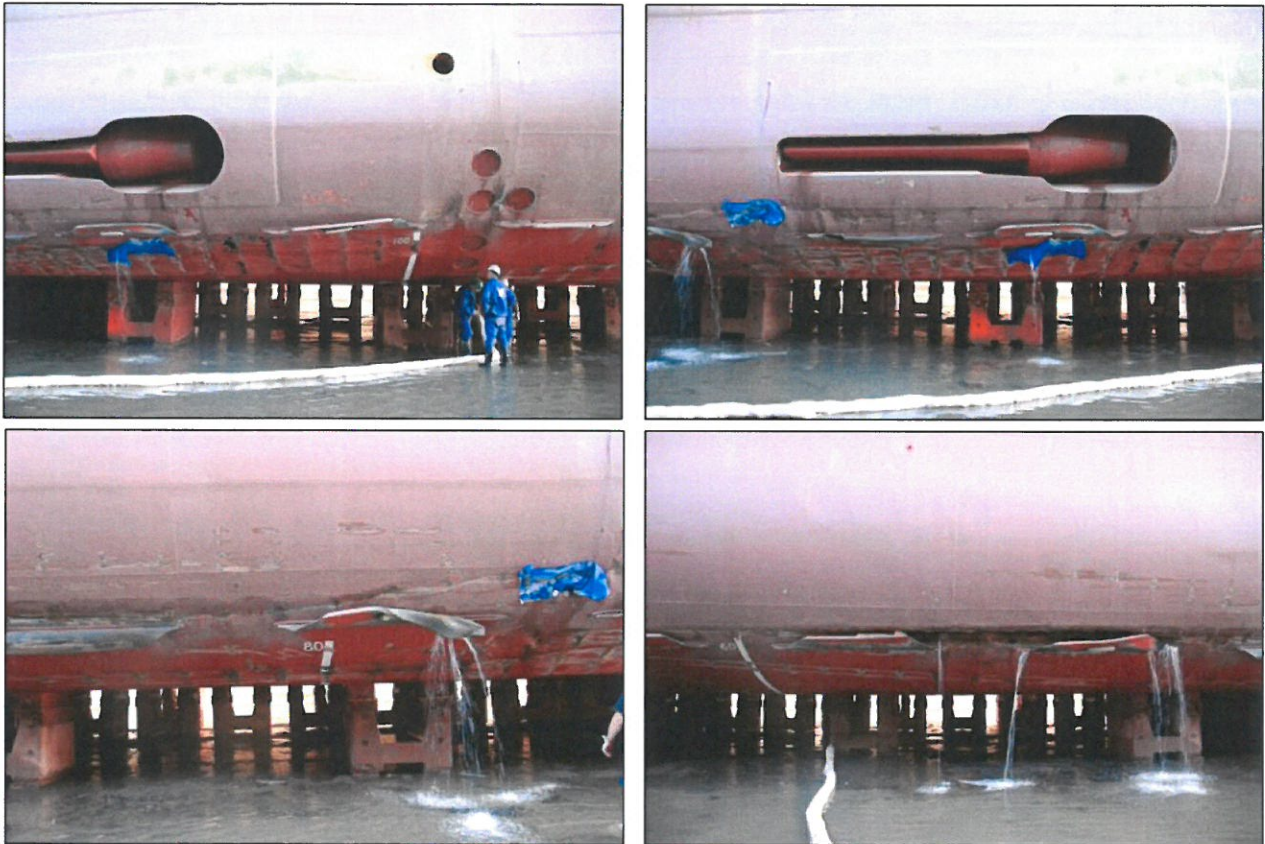


Figure 14: Hull penetrations at the starboard side between frames 60 and 101.
Source: STENA LINE AB

4. ANALYSIS

The investigation revealed no technical failure in the steering arrangement. It is therefore highly likely that the ship made contact with the breakwater as a result of the following factors: the helm was already turned to a hard starboard position when the switch was made from port bridge wing to hand steering at the centre helm. At that time, the helmsman assumed that the helm was in a neutral, centred position. Thus, when the master ordered port helm, and the helmsman believed he followed the order, he actually just decreased the starboard helm, and the ship kept turning to starboard. When the crew realized what was wrong, it was too late to avoid impact with the breakwater.

When a large vessel manoeuvres in a confined area such as a harbour, there is only a small margin of error between success and failure. In STENA NAUTICA's case, a relatively small erroneous action had severe consequences.

The design and operation of STENA NAUTICA's steering arrangement was vulnerable to erroneous actions. The arrangement allowed the switch from one control station to another without the watchkeeping crew having full knowledge of the helm and rudder positions. The system did not clearly indicate the helm's actual position (in this case hard starboard) before switching to centre manual steering. Further, no common procedure was followed when the control was shifted from bridge wings to centre hand steering: Some helmsmen operated the switch button themselves, while others did not. On the day of the accident, the helmsman had specifically asked the 2nd officer to operate the switch to ensure that it was done correctly.

The design of the centre helm was such that its position (port, starboard or centre) was not clearly indicated, especially at night. During the process of changing the steering mode, there was no indication of what action the helmsman took, because the other crewmembers could not visually see what position the helm was in.

The accident revealed a weakness in the overall design of the bridge layout. The position of the override steering made some officers prefer one system over another, because they wanted to avoid accidentally activating the rudder. In addition, when the bridge officers and ratings were applying different strategies for operating the system, it would at some point lead to confusion caused by a fixation on which mode the system was in. The strategy applied by the bridge crew was to repeatedly confirm that it was switched to helm, while in fact it had already been switched over.

As the ship was refitted with new and additional equipment, there had been little or no analysis of how the operators were actually working on the bridge. Making new equipment available in an operational environment changes the operational process and even though it can optimize the work, it also introduces new risks.

Also contributing to the accident was the time frame. Only a few minutes passed from the time when the bridge crew realized there was a problem (unintended scenario) until the first impact with the breakwater. This left them with a very short time in which to consider their options.

The extent and locations of the hull damages combined with the layout and dimensions of the bilge system meant that external assistance was imperative.

The successful outcome of the accident was caused by the immediate decision to return to the berth while the ship had power supply and was still manoeuvrable. Shortly after the ship was berthed, the water level reached some of the switchboards.

5. CONCLUSIONS

The accident happened as STENA NAUTICA was manoeuvring in a confined area where small margins of error gave little time for problem solving if an unexpected event occurred. The design and operation of the steering system was prone to erroneous actions because it allowed for several different strategies for operation. The unexpected event made the bridge crew fixate on the mode selection. Specifically the helm was designed in such a way that the helmsman could misunderstand the actual setting.

The master's decision to turn the ship and immediately return to berth may have been crucial to the outcome of the accident. With the amount of flooding caused by the damage to the underwater hull, and the ship's relatively limited bilge suction capacity, it is likely that much severer consequences would have occurred, had the master decided to continue the voyage outside the breakwaters.

6. PREVENTIVE MEASURES TAKEN

Following the accident, the company has implemented changes to its bridge procedures to ensure that the steering wheel is centred before takeover. The procedures furthermore prescribe that the officers operate the steering mode selection switches themselves. On STENA NAUTICA, it has been decided that switch of steering position, from bridge wing to centre, is to be done outside the breakwaters.

The hand steering wheel which was removed for the refit has been remounted on top of the existing wheel as a preliminary solution (figure 15). With this configuration, it is clearer to the bridge crew whether the wheel is in neutral. Further, a counterweight has been fitted to force the wheel in neutral when not activated by the helmsman. A fixing hook has been installed to keep the wheel centred when not used to avoid confusion.

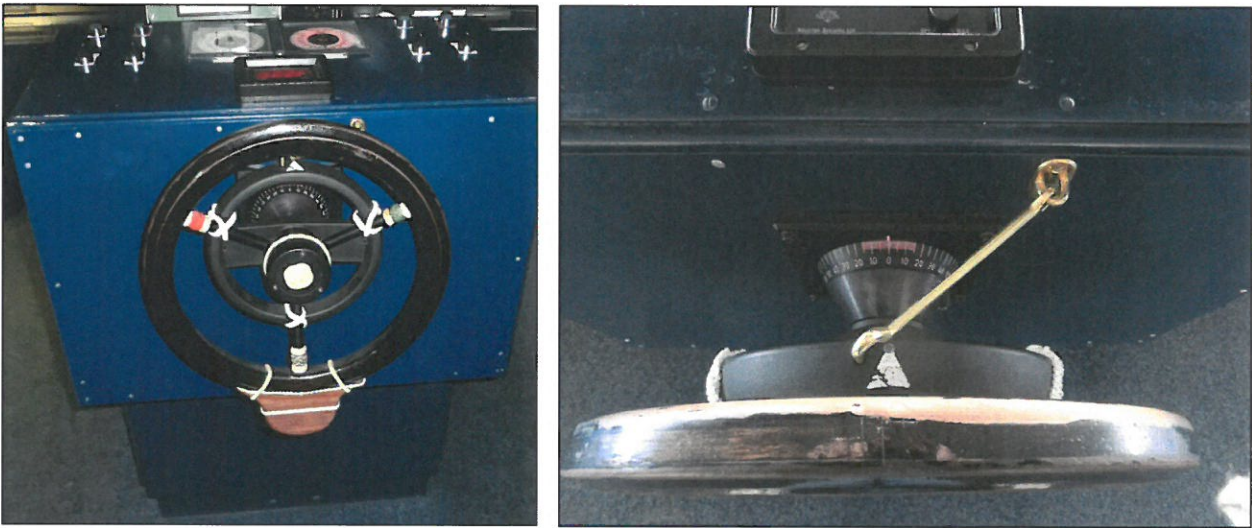


Figure 15: Hand steering wheel. Old wheel, counterweight and fixing hook fitted.
Source: DMAIB