DUTCH
SAFETY BOARD

# Shifting cargo causes emergency

Lessons learned from the occurrence involving the Eemslift Hendrika, 5 April 2021

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*Den Haag, July 2022*

*The reports issued by the Dutch Safety Board are public and available at www.safetyboard.nl.*

*Photograph cover: M. Witte*

## The Dutch Safety Board

If an accident or disaster occurs, the Dutch Safety Board will investigate its cause with the aim of drawing lessons for the future. In this way, the Dutch Safety Board contributes to improving the level of safety in the Netherlands. The Dutch Safety Board is independent and decides for itself which occurrences it will investigate. The Dutch Safety Board focuses particularly on situations in which people are dependent for their safety on third parties, including government or companies. In certain cases, the Safety Board is under obligation to carry out an investigation. Its investigations do not address issues of blame or liability.


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N.B: This report is published in the Dutch and English languages. If there is a difference in interpretation between the Dutch and English versions, the Dutch text will prevail.

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# RECOMMENDATIONS

The perception among a part of the industry that a captain cannot receive instructions has historically grown. Traditionally, a captain was dependent on himself and his crew during sea voyages. In the present time, shore communication with ships has improved and there is regular contact between the office and the ship. This allows an operator or ship owner to give instructions if a situation requires it. The Dutch Safety Board therefore issues the following recommendation.

*To the operator Amasus:*

1. As a company and owner of ships use, in exceptional situations where the safety of the crew and the ship is or is likely to be compromised, the possibility of imposing instructions on the captain.

Shipping of cargo is a process that consists of a number of fundamental or conditional steps. Each of these steps involves one or more parties who play a certain role in the process. This incident has shown that it is important for all parties involved to draw each other's attention to unusual characteristics of a cargo, as is already prescribed for heavy lifts, even if it does not fall into the category of a 'heavy lift'. To promote this, the Dutch Safety Board issues the following recommendations.

*To the operator Amasus:*

2. Ensure that the stowage and lashing of unusual cargo, i.e. cargo with an eccentric centre of gravity or abnormal shape, can be carried out on board in such a way that reality is in accordance with the plan. This incident shows that when drawing up a plan that is feasible in practice, attention should be paid to at least the following topics:
   a. Making demonstrable use of the existing knowledge and experience of shipping unusual cargo that is present in the company and its employees.
   b. Using input data for the lashing calculations that are accurate and in accordance with reality.
   c. Requesting all necessary information for the shipping of cargo and sharing this with the crew.

3. If the original lashing plan is deviated from, check whether the changed method of stowing and/or lashing is sufficient to be able to transport the cargo safely.

J.R.V.A. Dijsselbloem
Chairman Dutch Safety Board

C.A.J.F. Verheij
Secretary Director

# 1 INTRODUCTION

On 5 April 2021, the Dutch cargo vessel Eemslift Hendrika ran into difficulties off the coast of Norway. At that time the vessel was about 60 nautical miles (NM) to the west of the Norwegian coast in a northwestern storm. The vessel carried several boats on deck and the cargo hold contained six azimuth thrusters[1] and a catamaran. The vessel was on its way from the German port of Bremerhaven to Kolvereid in Norway.

During the voyage, a number of the azimuth thrusters shifted in the cargo hold and punctured an anti-heeling tank and ballast water tanks of the ship. The water then flowed from the ballast tanks into the cargo hold. As a result of the shifting azimuth thrusters and the ballast water leaking into the hold, the vessel developed a starboard list. The wind was northwesterly with a force of 9 beaufort and the waves were ten to fifteen metres high. The list increased to about 30 degrees which caused the situation to become alarming. Eight of the twelve crewmembers were evacuated. The remaining four crewmembers tried to keep the vessel in a stable condition. Late afternoon the four remaining crewmembers were also evacuated and the vessel continued on its way on automatic pilot at a power setting of 40 percent.

In the morning of April 6 it became clear that propulsion had cut out, the wind blowing the vessel slowly in the direction of the Norwegian coast. The list increased to about 45 degrees. During the night the vessel also lost a portion of the deck cargo, the green workboat (figure 1). When falling overboard, the workboat took the jib of the deck crane with it. The crane jib got stuck under the waterline and caused damage to the hull of the vessel. On April 7 the vessel had neared the Norwegian coast to a distance of seven NM before a tug line could be secured after which the vessel could safely be towed into Ålesund harbour.

1 An *azimuth thruster* is a special kind of ship's propeller. The screw propeller is fitted in a housing (nozzle) under a ship. As the nozzle itself can be rotated through 360 degrees, a conventional rudder is no longer required and the vessel is more manoeuvrable.


*Figure 1: The listing Eemslift Hendrika off the Norwegian coast. (Source: Norwegian Coastguard).*

*Classification*
The occurrence has been classified as a very serious accident as defined in the Casualty Investigation Code of the International Maritime Organization (IMO) and Directive 2009/18/EC of the European Parliament and Council. This means that the Netherlands, as the flag state, bears the obligation to ensure that an investigation is carried out. If from the assessment it transpires that lessons can be learned or general safety can be improved, the Dutch government is obliged to perform the investigation. This obligation to carry out an investigation is also laid down in the Safety Board Decree.

Based on the assessment, the Safety Board carried out a safety investigation. This report is the result of that safety investigation.

*Investigation approach and accountability*
Because of the restrictions imposed in relation to the COVID-19 pandemic, it was not possible to travel to Norway to perform investigation. Four members of the crew were interviewed by the Safety Board using video conferencing immediately after the occurrence. In conjunction with colleagues of the Norwegian Safety Investigation Authority (NSIA) it was possible to perform investigation on board of the vessel. Two colleagues of NSIA boarded the vessel in the days after the occurrence to collect investigative data on behalf of the Safety Board. In addition, the Safety Board was given access to relevant documents, photographs and the ship's Voyage Data Recorder (VDR). After the occurence and during the time the vessel was moored in Harlingen for repairs, investigators boarded the ship to conduct further interviews and gather investigation information.

On the basis of the analysis of this investigation information, the Dutch Safety Board drew up this report, which offers answers to the following investigation questions:

- What caused the vessel to develop a severe list leading to the eventual evacuation of the crew?
- What lessons can be learned from this occurrence?

*Demarcation*

What stands out the most about this incident is the fact that the vessel found itself in a northwestern storm off the coast of Norway. This does not necessarily mean that a vessel should get in trouble. The emergency situation occurred because the cargo of azimuth thrusters started shifting in the hold and, as a consequence, damaged a couple of tanks. To determine how it was possible for the ship to be in those conditions and to what extent the way in which the cargo was lashed contributed to the incident, the investigation focusses on the predicted and actual weather conditions and the process of shipping a cargo of azimuth thrusters.

The response of the crewmembers to the emergency, the rescue operation carried out by the Norwegian authorities and the salvage operations were not investigated by the Safety Board. It is difficult to assess beforehand how individuals will respond in emergency situations. The possibility to draw lessons is therefore limited. The rescue operation carried out by the Norwegian authorities and the salvage operations were outside the control of the Board.

# 2 COURSE OF EVENTS

The Eemslift Hendrika is a multi-purpose ship owned by the Amasus operator and is being chartered by the Starclass company that specializes in the transportation of yachts. Every three weeks the vessel makes a voyage between Norway and Turkey and visits a number of fixed port of calls. When the cargo space is not taken up by yachts, Amasus can accept complementary cargo on its own accord. This means that apart from the ports called under the terms of the contract with Starclass, additional ports may be visited en route. On the northbound voyage during which the occurrence took place, the ship was loaded with a mix of charter cargo and other cargo.

## 2.1 Timeline of the occurrence

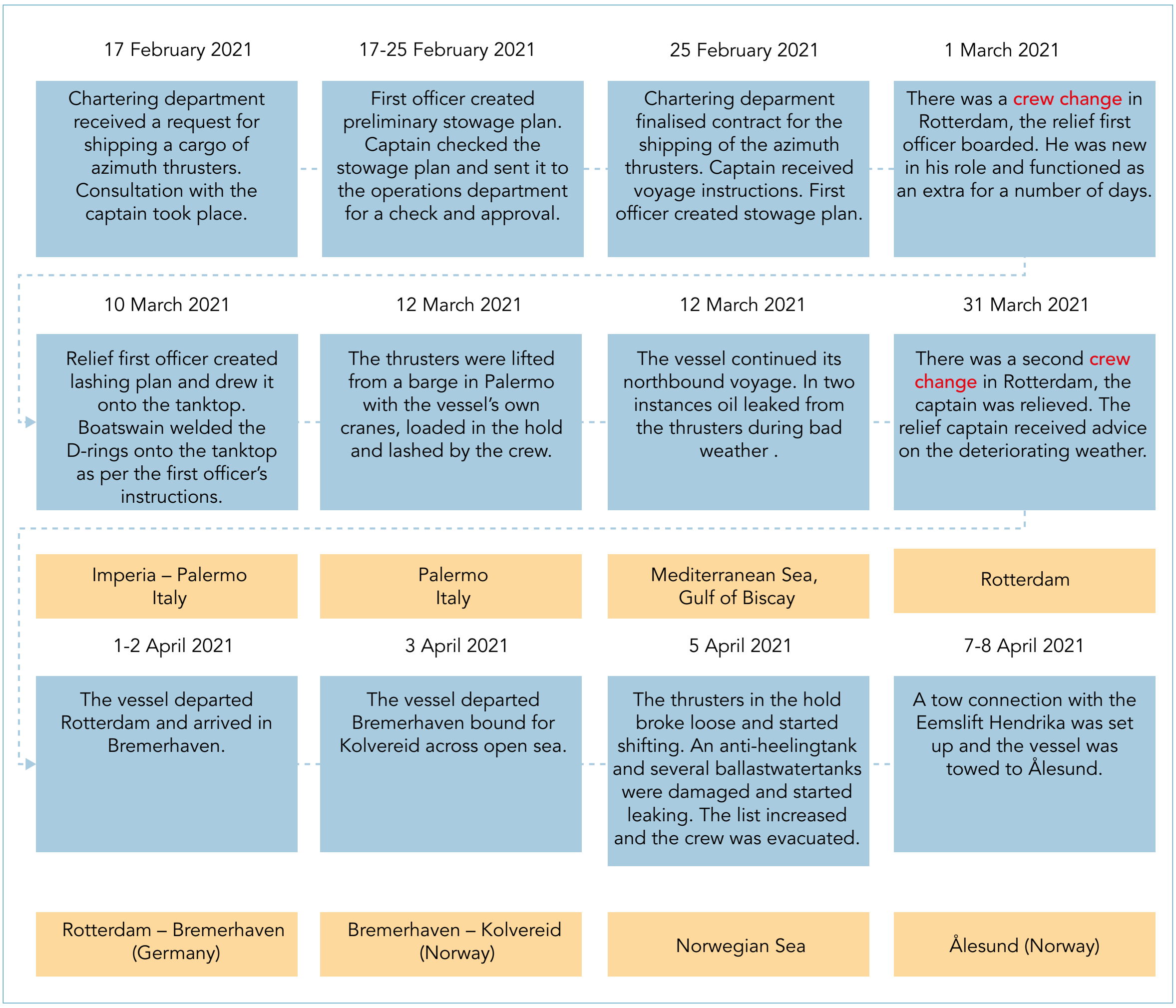


*Figure 2: Timeline of events leading up to the occurrence.*

## 2.2 Course of events

*Shipping request for a cargo of azimuth thrusters*
On 17 February 2021, the operator received a request from an Italian freight broker for the transportation of six thrusters from Palermo (Italy) to Ulsteinvik (Norway). As the ship would be on its northbound voyage form the Mediterranean to Norway, the chartering department contacted the captain and first officer to discuss the option for taking on this cargo in order to determine if it would be possible to transport this cargo.

For the transportation of the thrusters a transport contract was issued on 25 February 2021, stating, among other things, where and when loading needed to take place, what the cargo would consist of and where the cargo needed to be unloaded. The transport contract for the thrusters indicated that the ship's crew would take care of loading, lashing and unloading of the cargo. This entailed the crew loading the cargo on board using the ship's cranes and lashing the cargo with the ship's own lashing materials. Upon arrival at destination the ship's crew would also unload the cargo.

The information in relation to this request received by the captain and first officer from the chartering department consisted of voyage instructions and contained information on the ports of loading and unloading; details on the thrusters; a technical specification of the thrusters including a drawing indicating the dimensions and centre of gravity; and the weight of the thrusters - 60 tons each. The information included the remark that the thrusters contained oil. Figure 3 shows the dimensions of the thrusters in millimetres. The first officer made a stowage plan based on the voyage instructions, that was approved by the captain and sent to the chartering department to be checked. The captain had been working for the operator for several years but was now on his first voyage in his new role as captain. The approval of the stowage plan sent to the chartering department also acted as confirmation by the captain that, in his opinion, it should be possible to load and ship the thrusters.

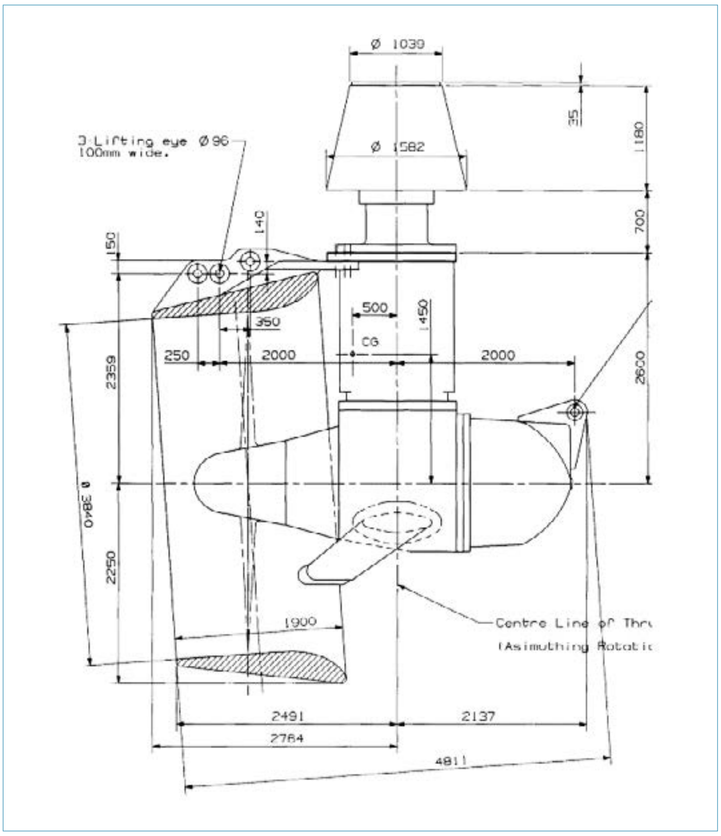


*Figure 3: Dimensions of the azimuth thrusters. (Source: Amasus)*

Because cargo was loaded or unloaded at every port of call, the stowage plan was revised continuously. In this way it was possible to keep track of the cargo on board and any remaining cargo capacity. Furthermore, each time cargo was loaded or unloaded the ship's stability needed to be checked.

On March 1 a crew change took place in Rotterdam. The first officer was relieved by a first officer who was doing his first rotation as first officer and on board the vessel. The relieved first officer stayed on board for a few days more to ensure an extensive handover and assist the relief first officer where necessary.

Prior to loading the thrusters, the relief first officer made lashing calculations based on the voyage instructions and stowage plan. These were checked by the captain and sent to the office for approval. According to the calculations each thruster would require ten lashings. To be on the safe side, the relief first officer and the captain decided to use twelve lashings for each thruster and also decided that the load capacity of the lashings on its own would be sufficient and that cargo stoppers[2] would not be necessary. On the basis of this information the relief first officer determined how the lashings should be placed in the hold.

2 Metal plates that are placed tightly to the underside of the cargo and welded to the deck to prevent the cargo from shifting

Subsequently he marked the location of the thrusters and the lashings in the cargo hold. This lashing plan[3] was not recorded on paper but the relief first officer kept it in his head.

The lashings consisted of lashing chains, some of which combined with polyester slings and secured to D-rings on the tanktop[4] of the cargo hold. Because the number of integrated D-rings in the cargo hold was insufficient, additional D-rings were welded on the tank top. The harbour authorities of Palermo did not give authorisation for hot work (welding) while in port, making the captain and relief first officer decide to weld the D-rings to the tank top during the voyage to Palermo.


*Figure 4: The thrusters as they were stowed in the hold, showing the lashings. Photo taken from the front of the hold looking aft. (Source: Amasus)*

The D-rings were welded on by the boatswain who was in possession of a welding certificate. The positions of the D-rings and the thrusters were plotted in the hold by the relief first officer. The welds were visually inspected by the relief first officer after completion. Out of habit and personal interest, the relief first officer took pictures of the entire work process. The lashing calculations were revised after the thrusters had been loaded and lashed in order to record the actual situation and for checking the lashing system. During the hoisting operations the crane registered the weight of one thruster at 52 tons. The thrusters were placed on sections of plywood. On average, 14 lashings were used for securing each thruster. When redoing the lashing calculations, a weight of 52 tons and 14 lashings for each thruster were used.

3 A plan containing a drawing of the lashings. The plan includes a drawing of the number and configuration of the lashings, the lengths of the lashings and the angles at which the lashings need to be installed. A list of properties of the lashings will be added to this plan, one of which relates to the load capacity.

4 Designation of the deck at the bottom of the hold

*The voyage in the Mediterranean*

After loading the thrusters in Palermo on 12 March 2021, the vessel left the same day for its northbound voyage to Norway. During this voyage the following ports were called at: Naples, Ravenna, Porto Maghera and Ancona in Italy; Sibenik and Pula in Croatia; Corfu in Greece and Alcudia in Spain. In these ports various cargos, mainly yachts, were loaded and unloaded. In each port of call the stowage plan was revised to reflect the new situation. The lashing calculations were not revised. The vessel continued its voyage to Rotterdam, where, in addition to loading and unloading of cargo, a crew change was to be effected.

The journey from the South of Europe to the North of Europe was uneventful. However, the crew reported that at two instances oil had been leaking from the gearboxes of the thrusters. Nearing Corfu the vessel encountered strong winds, force 9 beaufort, but since it was blowing from windward shore there was no swell. Yet a few drops of oil leaked from the azimuth thrusters. The same occurred when sailing in the Bay of Biscay. The weather became worse and again a few drops of oil leaked from the gearboxes. In both instances the oil was cleaned up using the appropriate means available on board and no further problems were encountered.

On 31 March 2021, the ship arrived in Rotterdam where the captain was relieved. The relief captain met the captain in charge on board of the vessel and received from him a handover of duties. An inspection of the vessel formed part of the handover, and during the inspection the deck cargo was inspected but the cargo in the hold was not. The relief captain trusted that the cargo in the hold was sufficiently lashed and secured. The handover was supplemented by a paper edition. During the handover, the relief captain was informed of the worsening weather that was predicted on the route to Norway. The ship's owner also came on board and advised the relief captain to use pilotage when navigating the Norwegian fjords because of the predicted bad weather.

From Rotterdam the vessel sailed to Bremerhaven where it arrived on 2 April 2021. Here the cargo superintendent came on board to assist the first officer with unloading a green workboat upon arrival in Kolvereid (Norway).

*The emergency*

In the early morning of 3 April 2021, the vessel left Bremerhaven and proceeded across open sea in the direction of Kolvereid, Norway. Prior to the voyage from Bremerhaven to Kolvereid there was wind force 8 to 9 beaufort on the planned route. This transpired from the weather forecasts the captain had access to in the weather routing[5] programme SPOS and the NAVTEX[6] messages related to the North Sea and Norwegian Sea areas. Based on these forecasts the relief captain decided to take the route across open sea.

The actual weather conditions on 5 April 2021, at the time of the occurrence, were in line with the forecasts. On the day of the occurrence the speed of the northwesterly wind varied between 34 and 40 knots. At 7.5 metres early in the day, the measured wave heights were a bit higher than predicted and reached 10.8 metres by late afternoon. There was a swell from the west/northwest rising to 4.5 metres in height. Because both the swell and the wind came form the same direction, these two phenomena amplified each other.

As a result of the wind and the waves, the vessel rolled and pitched violently, and in the evening of April 4 the relief captain had changed the course of the vessel to northwest during his watch in order to keep the bow into the waves[7] to reduce the rolling movement of the vessel. He had also reduced the ship's speed. After taking over navigational wtach, the second officer had taken the helm at 0.00 on April 5 and followed the example of the captain by keeping the bow into the wind. At 04.00 hours, the relief first officer took over navigational watch. He tried to alter the course in order to steer in the direction of the Norwegian coast, but the rolling movement was too violent prompting him to steer into wind.

During his watch the relief first officer received a bilge high level alarm (HLA) twice, once at 05.30 hours starboard and once around 06.00 hours port forward. The bilge was pumped out both times and after the first bilge HLA the relief first officer asked the boatswain to check the cargo hold together with a seaman. The second bilge HLA activated when the boatswain and seaman were in the hold. It was unclear what had caused the water to flow into the hold and how much water it was. As the relief first officer was not satisfied with the answer of the boatswain, he decided to go to the hold himself to check as soon as his watch ended. After watch handover to the captain at 08.00 hours, the relief first officer together with the cargosuperintendent went to check the hold at 08.20 hours. Before they went to the hold, the relief first officer and cargosuperintendent went on deck to secure a small crane which had gotten loose. The six ton crane was secured with four lashings of which the load capacity was ten tons each.

5 *Weather routing* is a commercial service offered by companies to shipping for the purpose of optimizing their journey by plotting a route using weather forecasts and information on sea conditions.

6 NAVTEX (NAVigational TEXt Messages) is an international automatic radio telex service for transmitting maritime safety messages such as navigation and meteorological and weather warnings and urgent messages, such as SAR-messages, from coastal stations to shipping.

7 Steering the bow of the ship into the direction of the waves and reducing speed in order to ride the storm as comfortably as possible.

The bilge is the lowest area of a ship below the waterline where the two sides of a ship meet at the keel beam. At various locations in the vessel there are bilge pits where bilge water is collected. The bilge pits are fitted with a float that will activate the bilge HLA if the bilge water in the bilge pits reaches a certain level. The bilge pumps, with their suction line connected to the bilge pits, can be used to pump out the bilge pits. The HLA of this vessel is audible and visible on the bridge, in the engine room and in the chief engineer's hut.

*Figure 5: Bilge well in the hold of the vessel.*

Upon arriving in the hold, the relief first officer and the cargosuperintendent found a large quantity of water and noticed that the three most forward stowed azimuth thrusters had dislodged. One of these three had come loose first and had caused a domino effect, causing the other two to also become dislodged. It was observed that the thrusters had punched a hole in the portside anti-heeling tank and that water was running into the hold. The anti-heeling tank was completely filled and contained 355.2 m$^3$ of water, rapidly filling the hold. Upon their discovery the relief first officer and the cargosuperintendent went to the engine room where they ordered the engineers to start the open top pump[8].

8 The Eemslift Hendrika can be operated as a merchant vessel without cargo hatches. Therefore she is designated as a so-called open-top-freighter. In order to be operated with open top, meaning without hatches, a vessel must comply with a number of requirements. One of these requirements is that the bilge system should have sufficient pumping capacity to be able to handle a certain flow of incoming rain water or sea water. At least one (Bilge Pump Open TOP (BPOT)) of the three mandatory pumps must have the capacity as specified in the International Maritime Organization (IMO) regulations. The other two pumps combined should have a capacity that is equal to or higher than the capacity of the first pump.

The valves were opened and the pump was started but the pump was not operating properly with fluctuating pressure. The pump was alternately showing proper and improper suction.

*Figure 6: The situation in the hold at the time of the occurrence. The photo on the left shows that the front three thrusters have detached. The photo on the right shows part of the water in the hold. (Source: Amasus)*

When the relief first officer and the cargosuperintendent could hear that the open top pump did not work properly, they placed a submersible pump in the hold and lowered it in the portside bilge pit. However, this pump also did not perform as required because the discharge head was too high. Shortly thereafter, another tank for ballast water was impacted and holed by one of the thrusters. In the meantime the list had increased to about 30 degrees during rolling movement.

At 09.40 hours the relief first officer informed the relief captain on the bridge of the critical situation in the hold. First he tried to inform the relief captain from the hold using VHF but received no reply. Subsequently the relief first officer went to the bridge. On his way to the bridge, the relief first officer woke the second officer. When the relief first officer arrived on the bridge, the relief captain started deballasting the leaking tanks. The second officer also arrived on the bridge and took over the deballasting operations from the relief captain. At 10.10 hours the relief captain went to the hold to view the situation for himself. At the same moment the relief captain entered the hold, the vessel started to roll violently. The three thrusters that had worked loose earlier slid from one side to the other, while the other three were still lashed securely in their original position. The movements of the vessel became so extreme that the cargosuperintendent thought it possible that the stability of the vessel was threatened and that the situation might become uncontrollable.

The cargosuperintendent had previous experience as captain on board of the vessel and naturally took the command from the relief captain who had frozen under the circumstances. The cargosuperintendent gave the order to clear the hold, upon which the relief captain, the chief engineer, the relief first officer and the cargosuperintendent left the hold. The cargosuperintendent ran to the bridge and on his way there ordered the seamen to put on their survival suits. Upon arrival on the bridge the cargosuperintendent sent out a distress call around 11.00 hours. At that time the vessel was located some 60 NM off the coast. The Norwegian coastguard responded almost immediately, asked about the situation and asked if assistance was needed. Because of the very dire situation it was decided to evacuate a number of crewmembers. The Norwegian coastguard sent an SAR helicopter. The cargosuperintendent took manual control of the vessel and remained standby on the VHF radio. The crew put on their lifevests and gathered on the main deck.

The SAR helicopter arrived at 11.24 hours. Eight of the twelve crewmembers were picked up by the SAR helicopter. The relief captain, chief engineer, cargosuperintendent and relief first officer remained on board to try to regain the ship's stability by pumping out the water from the hold. As the pumps of the vessel itself were not capable enough to perform this operation, the coastguard was requested to deliver two portable pumps. These pumps were flown in by helicopter. One of these pumps was successfully brought to the hold but because of the violent movements of the vessel two crew members were slightly injured in the process. Attempts to get the second pump into the hold were abandoned.

Early in the evening at 18.34 hours the cargosuperintendent decided to evacuate. The list increased, the weather deteriorated and night began to fall. A nightly rescue operation was undesirable and reduced the chance of success. In addition, three of the four crew members still on board were injured, one of which, the relief captain, was in worse condition. While on the bridge he had been thrown against the wall during a violent rolling movement of the ship.

The chief engineer, relief captain and relief first officer jumped from the rear deck into the water and were picked up by the helicopter. The cargosuperintendent switched the vessel to autopilot with the bow into the wind and engine power set at 40 percent ahead. He was the last crewmember to leave the bridge, also jumped into the water and was picked up by the helicopter.

All night the vessel continued to sail on autopilot into the wind at low speed. In the morning of April 6 it became clear that propulsion was inoperative, causing the adrift vessel to drift back in southwesterly direction. The list increased to about 45 degrees. The extreme movements during the night caused the vessel to lose a portion of the deck cargo, the green workboat, taking the jib of the crane with it. The crane jib got stuck under the waterline and caused damage to the hull of the vessel as a result of the constant impacts. At 10.00 hours the coastguard vessel KV Sortland arrived for assistance and remained on standby near the ship. Around noon the ship was within 50 NM off the Norwegian coast.

In the meantime the operator had contracted a salvage company to salvage the ship. On 7 April, the salvage company hired two vessels for assistance, the tugs BB Ocean and Normand Drott. The KV Bergen arrived at the location at 07.00 hours. Around 07.45 hours the vessel was only twelve NM off the coast.

In the evening of 7 April, salvage personnel managed to get aboard the Eemslift Hendrika. In the meantime one of the tugs had managed to shoot a line across to the ship enabling the salvage crew to connect a towing line relatively quickly. The vessel had drifted to only seven NM off the Norwegian coast and had thereby entered Norwegian territorial waters.

After the towing connection had successfully been established, the vessel was towed to Flatholmen in Alesund. There the vessel was stabilized further, the water was pumped from the hold and the vessel was inspected. The green workboat was also salvaged. The cargo had been damaged but no cargo was lost.

# 3 BACKGROUND INFORMATION

## 3.1 Crew

On 5 April 2021, twelve seafarers were on board of the vessel (table 1). The relief captain had been on board only a few days since relieving his predecessor in the port of Rotterdam on 1 April 2021. He had ample experience at sea and had worked for Amusus before through a temporary employment agency, both on the Eemslift Hendrika and her sister ships. He was familiar with sailing Norwegian waters.

The relief first officer was a new Amasus employee and was new to his role. This was his first journey on board of the ship.

*Table 1: Crew composition at the time of the occurrence.*

| Job | Nationality |
|---|---|
| **Relief captain** | Dutch |
| **Relief first officer** | Dutch |
| **Second officer** | Dutch |
| **Chief engineer** | Ukrainian |
| **Second engineer** | Dutch |
| **Cook** | Filipino |
| **Boatswain** | Filipino |
| **Seaman** | Filipino |
| **Seaman** | Filipino |
| **Seaman** | Filipino |
| **Cargosuperintendent** | Dutch |
| **Trainee** | Dutch |

The captain who was relieved in Rotterdam had been working for Amasus for a number of years. He started out as first officer and eventually became captain. The voyage from the Mediterranean to Northern Europe was his first rotation as captain. He also had sailed in Norwegian waters on a number of occasions.

## 3.2 The vessel

The Eemslift Hendrika was built in 2015 and came under the management of Amasus in 2017. The vessel is one of the heavy lift ships of the ship manager´s fleet and is fitted with two cranes for autonomous loading and unloading operations. The vessel is suited for carrying cargo on deck as well as in the hold. Along the hold there are several tanks for ballast water which are used to ballast the vessel in order to obtain stability.

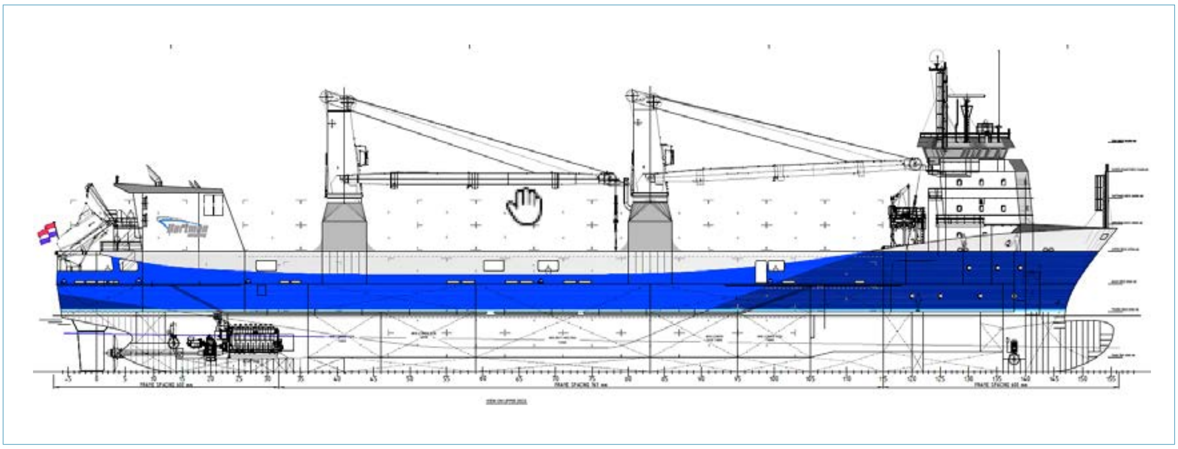

*Figure 7: Extract of the general layout of the vessel. (Source: Amasus)*

## 3.3 Ship Manager

Amasus is located in Delfzijl and offers a wide variety of services. The company is engaged in chartering and offshore activities but also offers tender services to wind farms and the like. The Eemslift Hendrika is owned by Eemslift Hendrika BV and is mainly used for the transportation of yachts.

# 4 ANALYSIS

The analysis of this occurrence focuses on the underlying contributing factors that lead up to the occurrence on board the Eemslift Hendrika and the role of the ship owner. The analysis included the use of the TRIPOD Beta analysis method.

The direct cause of the list of the Eemslift Hendrika was the shifting of the cargo of azimuth thrusters in the hold. A combination of factors eventually caused the thrusters to break loose. The underlying factors can be related to the to the weather conditions the vessel was in at the moment the incident occurred, and the way in which the thrusters were lashed and secured.

In order to determine the underlying factors, assessments were made of the way in which the shipment of the azimuth thrusters was carried out and how this relates to the applicable standards for carrying general cargo. The voyage of the vessel forms part of this assessment. For this purpose the Board has drawn up a reference with which the findings of this investigation were compared. This reference was compiled by examining various reference materials about stowing and lashing of (general) cargo; by interviewing several experts; and by talks with operators about the shipping of (general) cargo. The Board also had a third party, EVH Surveys, carry out a number of calculations. The calculation report can be found in Appendix A.

## 4.1 Weather conditions, sea conditions and movements of the vessel

Various sources on board were used to obtain a proper understanding of the expected weather conditions. A widely used source is NAVTEX that gathers meteorological alerts. In addition, operators often use the services of one or more meteorological institutes that provide weather forecasts. Crew members nowadays also have easy access to weather forecasts online through platforms such as Weeronline.

The captain and the officers on board used the *weather routing* programme SPOS. A programme that uses meteorological information for plotting the optimal route for the ship and showing weather forecasts at the same time. Apart from SPOS, the crew also used the meteorological warnings that arrived through NAVTEX.

Prior to the voyage from Bremerhaven to Kolvereid, severe weather was forecast. Figures 8, 9, 10 and 11 show the SPOS weather forecast on 3, 4 and 5 April. The forecasts on 3 and 4 April are valid for that date and the time that is shown on the figure. Using a prognosis of 36 and 42 hours, the forecasts for 5 April 0.00 hours and 06.00 hours are shown. The times are in UTC[9].

The weather forecast in SPOS is a chart. On the chart the surface pressure is indicated by lines of equal pressure called isobars. The closer these lines approach each other, the greater the differences in surface pressure over a given distance are and the greater the wind speed is. Wind directions are represented by lines pointing towards the direction the wind comes from. Depending on the speed, vanes are placed at the end of the line. Each vane represents 10 knots and each half vane 5 knots. In the chart, wind speeds are also noted down in knots. Areas where the wind speed increases are a deeper shade of red.

Also drawn on the chart are a cold front and a warm front. Fronts represent boundaries between air masses. A cold front is indicated by a blue line with blue triangles point towards the direction the cold air moves to. The cold air follows the front. A red line with semi-circles represents a warm front. The passage of a cold front is usually accompanied by showers.

9 *Coordinated Universal Time* (UTC) is a time standard based on the atomic clock and coordinated with the Earth's rotation.

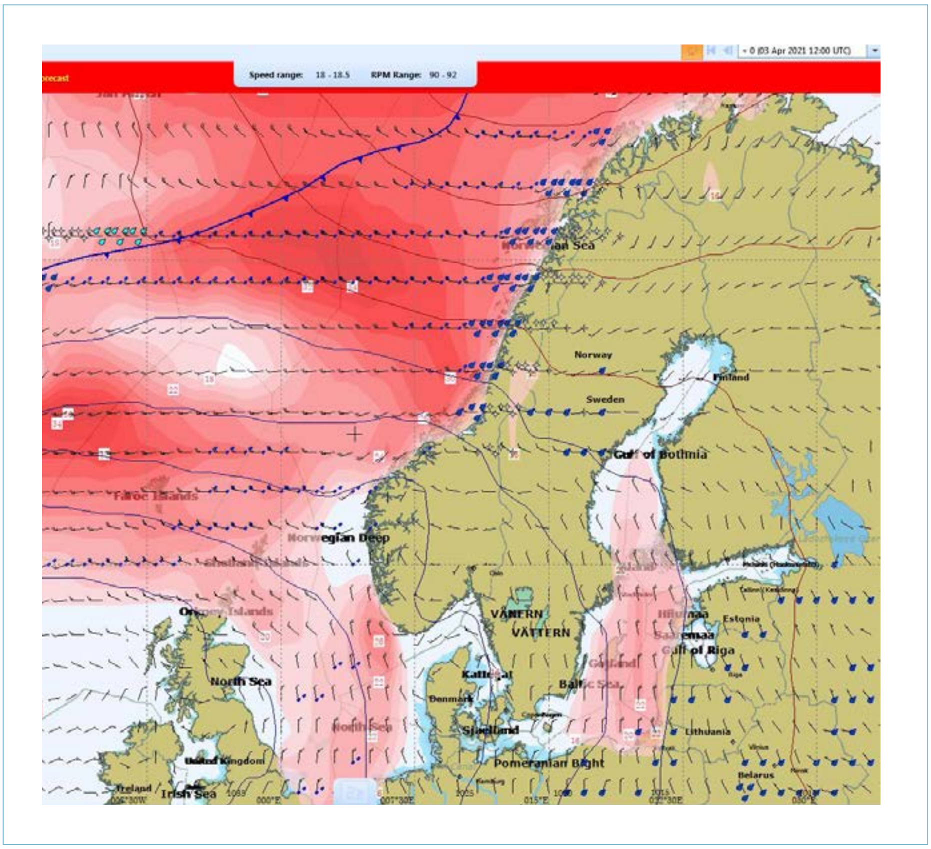


*Figure 8: The weather forecast on 3 April at 12.00 hours UTC without a prognosis.*

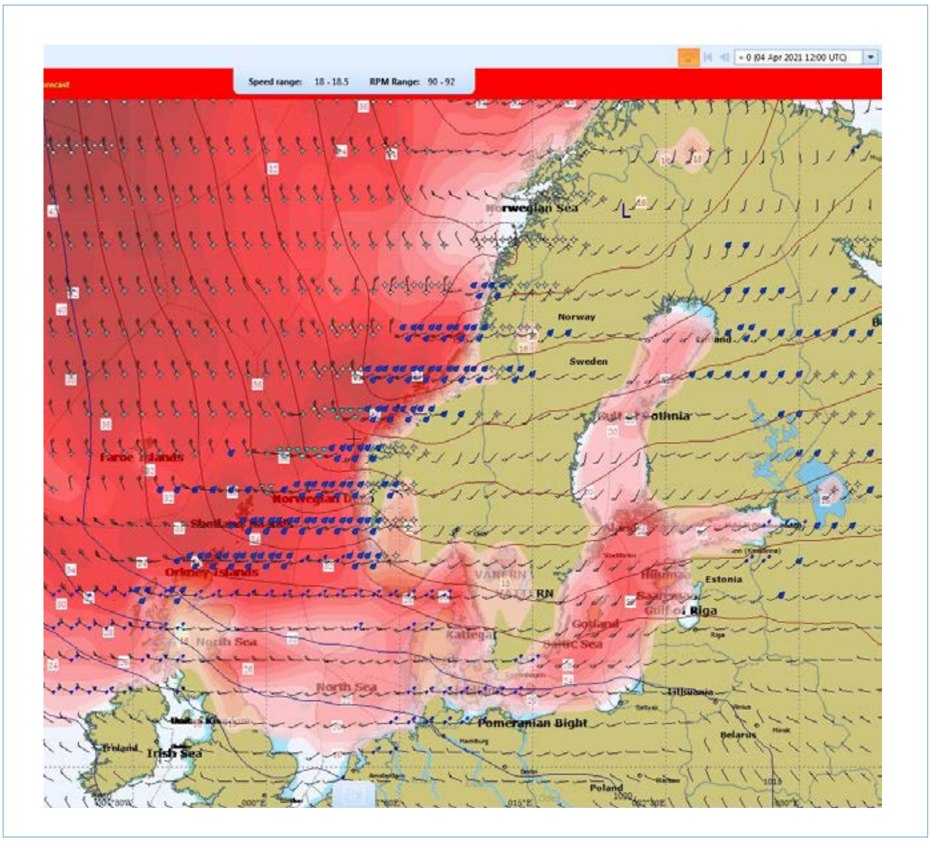


*Figure 9: The weather forecast on 4 April at 12.00 hours UTC without a prognosis.*

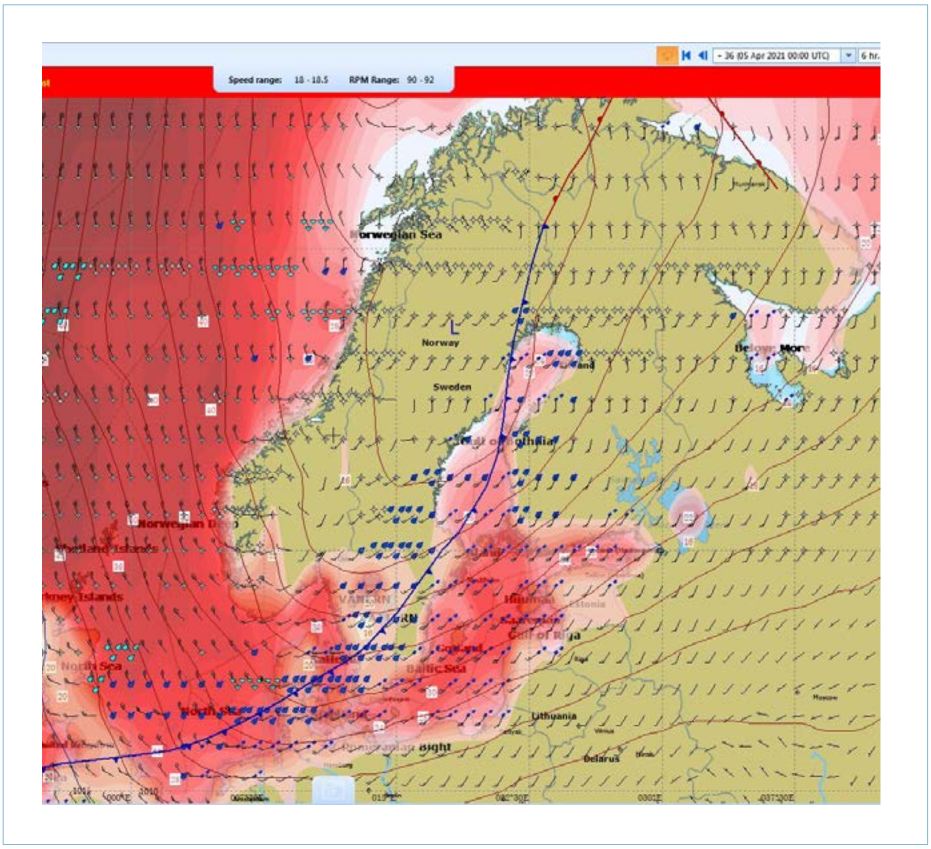


*Figure 10: The weather forecast on 3 April at 12.00 hours UTC with a prognosis of 36 hours on 5 April at 0.00 hours UTC.*

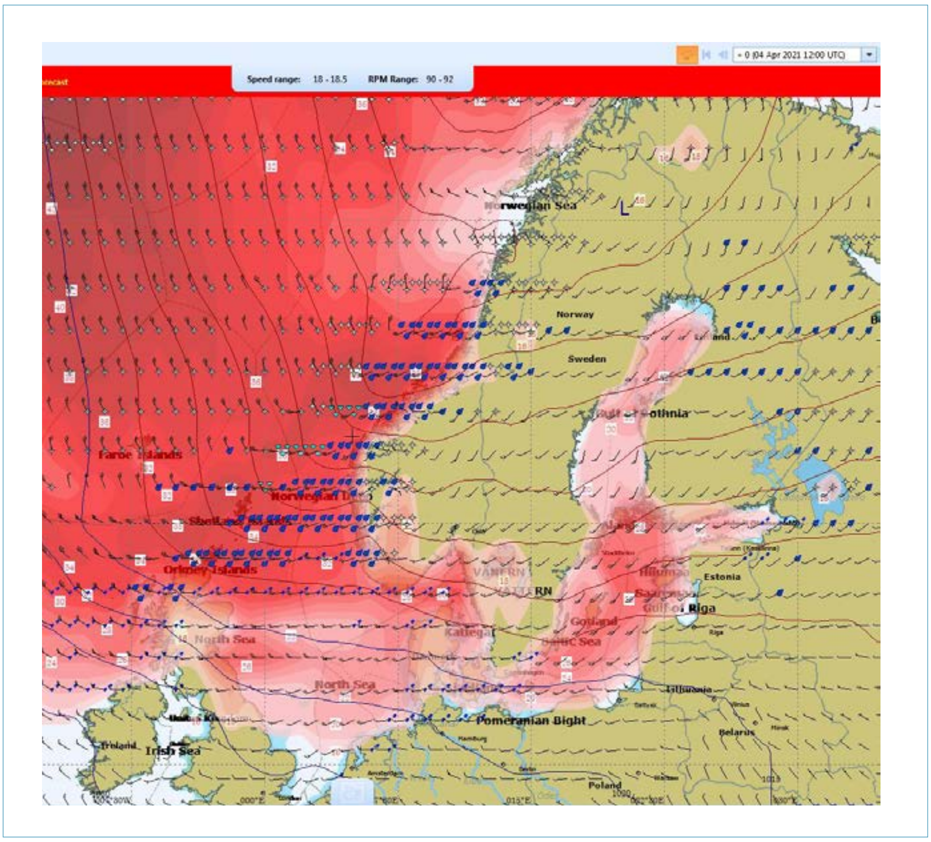


*Figure 11: The weather forecast on 3 April at 12.00 hours UTC with a prognosis of 42 hours on 5 April at 06.00 hours UTC.*

Over Norway a low-pressure zone formed. North of the Shetland Islands, at open sea, a northern wind was predicted with wind speeds of up to 50 knots (10 beaufort) and wave heights of 12.5 metres. On 3 April, the day the vessel departed from Bremerhaven, a northern wind with a wind speed of 22 knots (6 beaufort) was predicted for the North Sea area. Off the coast of Norway a wind with speeds of 24 to 30 knots (6 to 7 beaufort) was predicted. The wind direction was west but would turn to the north, accompanied by an increase in wind speed to 40 knots (8 beaufort). The waves in the coastal area of Norway were expected to be 5 to 6 metres high on 3 April and between 7 to 9 metres high on 5 April. The predicted swell came from the west.

The NAVTEX messages of the Dutch coastguard presented a similar image of the weather forecast in the North Sea area from Bremerhaven, a northwestern wind with a wind force of 3 to 4 beaufort was predicted. The wind would turn to a southwesterly direction with an increase in force of 5 to 6 beaufort. On 5 April the wind force would increase to 7 to 8 beaufort, possibly 9 beaufort. Messages of the Norwegian coastguard predicted on 3 April a northwestern wind with a wind force of 8 to 9 beaufort for the coastal area of Norway. Later messages predicted a wind force of 9 to 10 beaufort off the Norwegian coast.

The relief captain considered the risk of sailing across open sea under the predicted weather conditions as acceptable and therefore decided to select this route. It can be assumed that the relief captain was aware of the forecasts of 8 to 9 beaufort off the coast of Norway and the effect of the northwerstern storm on the wave heights.

Under these conditions it is possible that extreme high waves occur when a wind field of a northwestern storm moves in the exact direction of the swell. Low-pressure weather systems almost always move from the west towards Norway and often gain in force when crossing the northern part of the Atlantic. When combined with the large differences in temperature between the various ocean currents and large land areas such as Greenland, this phenomenon causes both the wind force and the wave height to increase even more. Especially if the supplied air is much colder than the sea water. This causes the waves to grow faster than normal. Moreover, under these conditions showers and gusts of wind are formed which also contribute to wave growth. At such moments, waves of 12 metres high have been measured along the Norwegian coast. In parts of the Norwegian Sea, where the water is much deeper, waves of up to 20 metres can occur. Nevertheless, waves as high as this off the Norwegian coast are quite rare in the month of April. In April the average wave height is 2.5 metres.

At different locations along the Norwegian coast the wind speeds and wave heights were determined using measurements and models. In combination with the details from the Voyage Data Recorder (VDR) the actual weather conditions could be ascertained. Wind speeds on 4 April varied between 41 to 55 knots (9 to 10 beaufort). Extremes of 63 knots (11 beaufort) were measured. These wind speeds were higher than predicted. At these moments it was still possible for the relief to take shelter or decide to take an inland route.

The actual weather conditions at the time of the incident were in line with the predictions. On the day of the occurrence the speed of the northwesterly wind varied between 34 and 40 knots (8 beaufort). Early in the day the measured wave heights were around 7.5 metres and by late afternoon they reached up to 10.8 metres. There was a swell from the west-northwest rising to 4.5 metres in height.

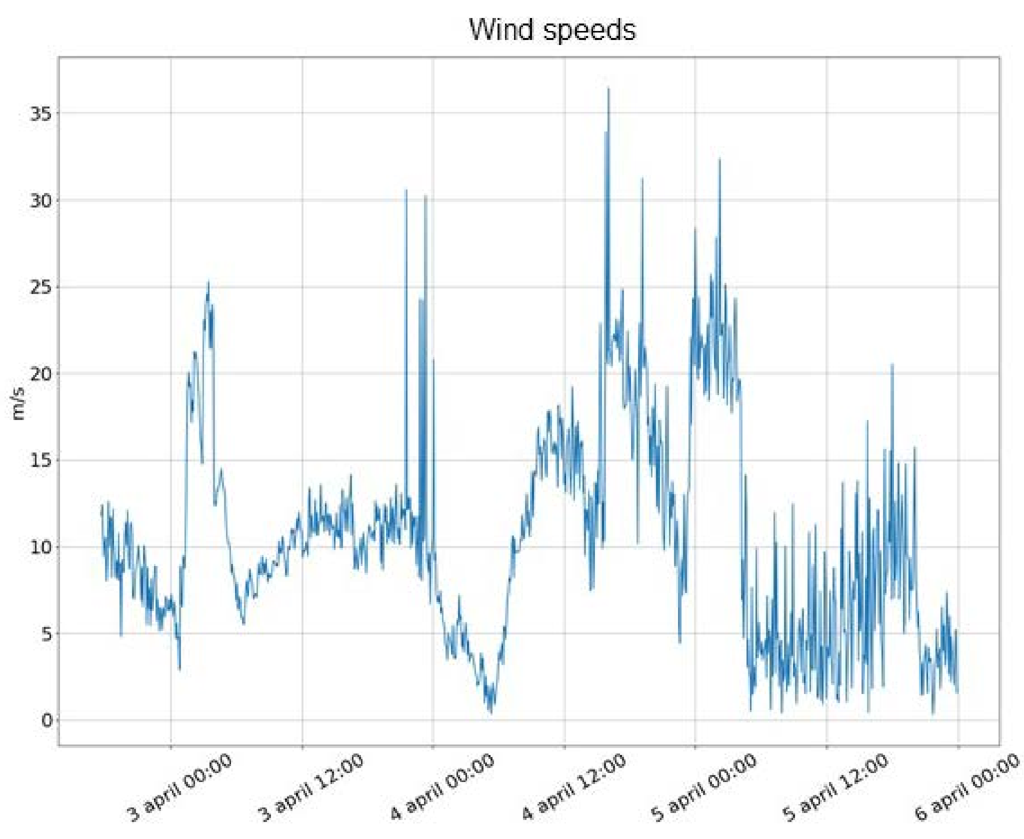


*Figure 12: An overview of the wind speeds in metres per second (m/s) as saved in the VDR on board of the vessel.*

Following the departure from Bremerhaven, the weather predictions deteriorated rapidly to wind force 9 to 10 beaufort. The vessel was west of Denmark cruising towards the Southern Norwegian coast. The high waves of some 12 to 15 metres at the time of the incident, caused by the combination of heavy seas and swell, were perpendicular to the route of the ship, causing it to roll and pitch heavily. It was virtually impossible to maintain course and speed which caused the relief captain to decide to ride the storm by steering the bow into waves and reducing speed.

When the relief captain took the decision to depart from Bremerhaven he did so trusting that the cargo in the hold had been effectively lashed and did not anticipate an additional risk created by the shifting of the azimuth thrusters. The relief captain had not checked the cargo in the hold himself, not during nor at any time after the handover. During a crew change handover, it is good practice of a relief captain to check the entire vessel.

From the fact that the thrusters became dislodged it was concluded that the lashing system could not cope with the weather and sea conditions. A properly devised lashing system in sound condition would be able to withstand the described conditions. This was substantiated during conversations with other operators and experts in the field of the lashing of cargo. This is also the starting point of the advanced calculation method as mentioned in Annex 13 of the CSS code. This calculation method incorporates calculated accelerations that may occur on board of a ship. The calculation of these accelerations for the CSS code was based on operations in unrestricted areas throughout the year and assuming a ship speed of 15 knots. This covers almost all weather conditions that can occur.

The weather predictions were such that the relief captain did not perceive the route across open water as an immediate danger. When the weather predictions deteriorated, the relief captain chose to stay on route. The ship was able to handle the predicted conditions but the captain underestimated the effect of the northwestern storm on the height and direction of the waves. This made it almost impossible to maintain course and speed, forcing the captain to ride the storm. Alternatives for the sea voyage were not utilised.

When making his decision, the relief captain was confident that the azimuth thrusters had been properly lashed, without having checked this himself. The lashing system as it was, could not withstand the actual weather and sea conditions.

### 4.1.1 Operational limits and recommendations

The operator has not established operational limits for its ships with regard to carrying cargo: the relevant responsibility and considerations lie with the captain. In some cases, the customer or insurance company impose limitations as to the weather conditions deemed suitable for the shipment in question. For instance, this is the case when shipping valuable yachts.

The Safety Management System (SMS) of Amasus describes a procedure for the planning of sea crossings. The procedure states that the captain is responsible for planning the voyage. This task may also be carried out by an officer in which case the captain remains ultimately responsible. The procedure points to having the correct nautical maps and publications for the intended voyage. These publications should contain accurate, complete and recent information on dangers to navigation that are permanent and predictable and of relevance to the safe navigation of the ship. The procedure makes no explicit mention of the requirement to consult weather forecasts. However, it is safe to say that the weather forecasts were consulted since this is a key activity when making an itinerary.

The CSM describes the actions that can or need to be taken when encountering severe weather. The CSM was written with the preservation of the cargo and the effect of the cargo on the safety of the ship in mind. The focus is on describing the possible actions for lessening the accelerations that affect the ship and cargo as a result of severe weather. This specific section provides guidance on how to mitigate the forces exerted as a result of large accelerations. One of the points mentioned is to avoid areas with severe weather and heavy seas. The CSM does not define 'severe weather' but mainly asks for sound seamanship.

**Good seamanship**

Good seamanship is a so-called open norm in the regulations pertaining to shipping. Generally, actions will be considered to be good seamanship as long as the rules are being complied with. However, the norm also implies that in absence of explicit regulations the captain should take all precautions that are necessary to avoid dangerous situations. There might even be situations in which good seamanship requires to depart from the rules: when blindly following the rules results in damage to the ship, crew or a third party, it will be seen as bad seamanship.

For the voyage from Bremerhaven to Kolvereid, several options were possible. There was an option to use pilotage when navigating the Norwegian Fjords. Such a route almost always runs across inland waterways requiring only a small number of passages across open water. The main advantage of this option is that a ship will be better sheltered from wind and waves. The ship's owner advised the relief captain in several ways to choose an inland route as he found it unwise to take unnecessary risks while there was an alternative available. Costs and arrival times were no issue. With that the choice lay with the relief captain. The operator and owner did not forbid the captain to commence the voyage and neither did they instruct the relief captain to choose an alternative route.

The relief captain estimated the risk of sailing across open sea under the predicted weather conditions differently from the ship's owner and decided to select this route. His perception of the amount of paperwork involved in taking an inland route using pilotage played a part in the captain's reasoning. He also had some lesser experiences with the Norwegian authorities. These experiences played a part in the relief captain's decision to continue sailing and ride the storm.

From the *International Safety Management Code* (ISM Code)[10] it is ruled that the captain has the final responsibility on board of his ship. He shall ensure the safe navigation of the ship and its crew to the destination. When the safety of the ship and its crew is being compromised, the captain has the authority and responsibility to take adequate decisions and to ask the operator for assistance if needed. This is required by law and incorporated in the VSM of the operator. However, this fact does not mean that the captain cannot be obliged or instructed to follow proposed advice.

When severe weather was predicted, the relief captain received advice from various sources by way of guidelines in manuals or from the operator, but at no time were there fixed limits that required to be respected. The ship's owner advised the relief captain to take a route under pilotage through the Norwegian fjords, but this was not a direct order. The operator and owner did not forbid the relief captain to commence the voyage, neither did they instruct the relief captain to choose an alternative route.

Even though the relief captain did not see a direct danger in sailing across open sea under the predicted weather conditions, an inland route would have been a safer alternative.

10 ISM-Code chapter 5 – Master's responsibility and authority

## 4.2 Shipping the cargo of azimuth thrusters

The operator has contracted the vessel for carrying yachts. Outside this contract the vessel is allowed to carry other cargo when there is room for it on board. The chartering department receives some 6,000 shipping requests by e-mail every day. The requests are filtered for cargoes that are commercially attractive and technically feasible. Determining factors are: the type of cargo, weights and dimensions, and the current location and destination of the cargo. Depending on what has been arranged with the shipper, a different transport agreement may be issued for each separate cargo.

Upon receiving a shipping request, the chartering department first consults the operations department. The operator's general working method is that for each separate cargo item exceeding 100 tons in weight, the operations department makes a stowage plan and lashing calculation to check whether the cargo can be transported safely. If the cargo is less than 100 tons, this step is performed by the captain and the first officer on board the ship. In both cases, consultation takes place between the captain and first officer, and the office staff. Confirmation that the cargo can be carried on the relevant journey will be communicated back to the operations department by the captain, upon which the chartering department finalizes the contract.

### 4.2.1 The shipping request for the cargo of azimuth thrusters

On 17 February, the chartering department received a request for the shipping of six thrusters. The cargo was offered by a freight broker, an intermediate between the customer and the operator. The information provided with the request was limited and consisted of the following:

- Port of loading: Palermo, Italy - Fincantieri yard
- Port of destination: Ulsteinvik, Norway, maximum length 136 m - depth 6 (stern) - 17 m (bow)
- Time frame: 5 – 9 March
- Cargo: six azimuth thrusters - dimensions 673 x 500 x 481 centimetre - 60 tons each, azimuth thrusters filled with oil – non hazardous
- FAS / Liner out hook
- As part cargo
- Below deck
- Not stackable

Following consultation between the operator and the freight broker and during drawing up the contract, the freight broker provided the operator with further information concerning the cargo of thrusters and requested a number of guarantees. The guarantees to be issued by the operator related to the condition of the vessel and the condition of the systems and equipment to be used. A valid certificate of the lashing material was also requested.

The contract for shipping the thrusters was concluded on 25 February 2021. The information contained in the final contract for the cargo of the thrusters was divided into a number of categories and included the following:

- Details of the ship and the voyage

  The port of loading was Palermo in Italy and the port of unloading was Ulsteinvik in Norway. The contract also included further details on the ports of loading and unloading. The captain was responsible for the coordination of the loading and unloading operations. This included the responsibility for the proper lashing of the cargo.

- The cargo

  It was stated that the gearboxes of the thrusters contained oil which did not constitute a hazard during transportation. Subsequently, the instruction was received that loading and unloading of the cargo needed to be effected using the ship´s cranes, operated by the ship´s crew, insofar as allowed by the local authorities. This meant that all required materials needed to be available on board in order to carry out the loading and unloading operations as agreed. An important clause in the contract stipulated that all azimuth thrusters needed to have sufficient lifting and lashing points in order to carry out loading and lashing as safely as possible.

In addition to the information included in the contract, the operator had also received a technical specification of the azimuth thrusters which included a drawing with the dimensions and the position of the centre of gravity, and a photograph of one of the thrusters. The freight broker had not issued any instructions to the operator regarding the way in which the cargo needed to be lifted or lashed. The information also did not contain any operational limits or requirements for the allowed wind force or wave height with respect to the shipping of the thrusters. The information did not indicate where the lashing points of the cargo were located or what the load capacity was. The *Cargo Securing Manual* (CSM) of the operator does not mention what information an operator should ask for concerning cargoes to be shipped or what information is to be given to the ship’s crew.

*The Cargo Securing Manual*
The CSM describes how cargo must be stowed and lashed on board the ship. It is mandatory to have this manual on board of any seagoing vessel, and it provides guidance to the crew regarding the safe transportation of cargo. The ship's CSM includes a detailed description of the materials to be used, drawings, user manuals, maintenance schedules and also information on correct lashing, the forces exerted on the cargo, lashing angles and the number of lashings. It also states that the determined number of lashing devices must be checked using a calculation method.

The CSM is based on the *Code of Safe Practice for Cargo Stowage and Securing* (CSS code). This code offers guidelines for the correct lashing and securing of cargo issued by the International Maritime Organization (IMO). The code among other things deals with:

- The principles of safe loading and securing of cargo
- Severe weather conditions
- Shifting cargoes

The photograph of the thruster supplied by the freight broker shows two padeyes on the nozzle (figure 13). No further details of the padeyes were communicated to the operator and therefore their purpose and load capacity were unknown. The operator did not request further information on the capacity of the lashing points of the thrusters.

The photograph taken of the thrusters after these had been lashed shows that the number and the position of the padeyes varied from one thruster to another. The photograph provided by the freight broker shows two padeyes at 4/5 of the height of the nozzle. The photograph of the thruster in the hold shows one padeye at about half of the height of the nozzle. The photograph that was provided of one of the thrusters was not representative for all azimuth thrusters.

*Figure 13: The photo on the left is the one provided by the freight broker and shows an azimuth thruster with two padeyes. The photo on the right shows one padeye on one of the azimuth thrusters in the hold. Note that the position of the padeye differs from the position of the padeye in the photo on the left. (Source: Amasus)*

Although the contract stated that the azimuth thrusters were fitted with sufficient lifting and lashing points, it could not be determined with certainty where these points were located and what their capacity was when using the information provided to the operator. Both the purpose and the capacity of the padeyes on the nozzle were unknown, therefore it could not be assumed blindly that these were suitable lashing points. Furthermore, the number of padeyes and their position on the thrusters varied and there were discrepancies between the information received and the actual situation. As the padeyes were used for attaching the lashings, these discrepancies between the information available and the information required made the preconceived stowage plan impractical and made it difficult to use a symmetrical system for lashing.

The drawing showing the dimensions also shows the Centre of Gravity (CoG). The CoG is slightly eccentric and tend towards the coupling cone[11]. This means that the thruster can more easily tip over in the direction of the coupling cone than in the other direction. The specifications stated that the thrusters contained 5000 litres of oil but did not mention if the oil was completely contained or if it could move unobstructed in the gearbox, making it susceptible to wave motion. Although the eccentric CoG and the oil in the gearbox both need to be taken into account when lashing, the operator did not ask the freight broker for further information regarding the lashing of the azimuth thrusters. The technical specification and the photo of the thrusters were sent to the captain. When doing so, no specific mention was made of the eccentric CoG.

11 The part of the thruster that is connecting it to the ship.

The CoG as indicated on the drawing of the azimuth thrusters is a theoretical CoG. In reality the CoG can differ because of, for example, shifting of oil in the gearbox. The crew usually determined the CoG when the cargo was being lifted. In the same way, the CoG of the thrusters was determined by the relief first officer and the captain. When the azimuth thruster was lifted from the single lifting point, the thruster's nozzle was about horizontal. From this observation, the relief first officer derived that the thrusters' CoG was in the centre of its horizontal plane.

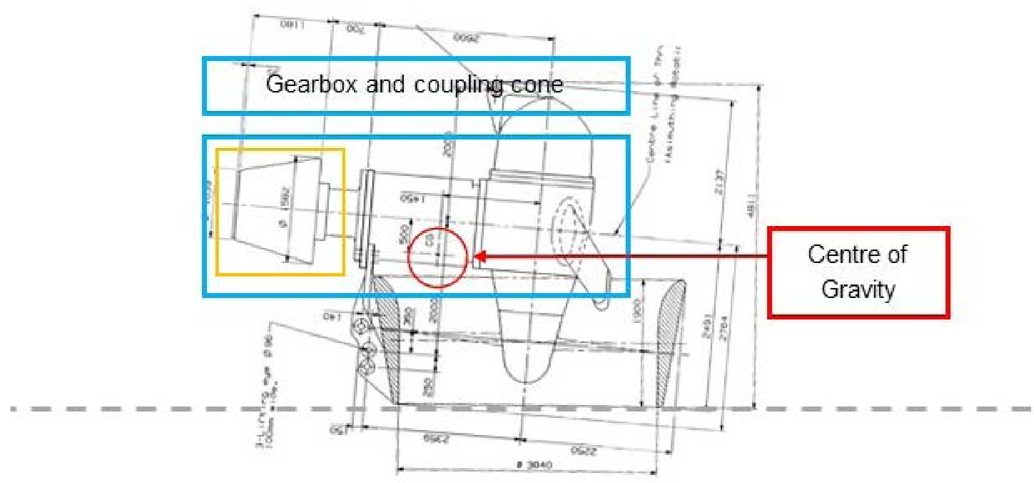


*Figure 14: Illustration of the components of the azimuth thruster and the theoretical position of the CoG*

The information about the cargo of azimuth thrusters provided by the freight broker to the operator did not contain any specific instructions for loading, unloading or lashing, or any detailed information on lashing points. The chartering department did not request more detailed and specific loading instructions and presumed that the information it had received was sufficient to be able to perform proper lashing of the azimuth thrusters.

The discrepancy between the available information and the required information made it difficult to devise a symmetric lashing system.

### 4.2.2 Loading and lashing the cargo of azimuth thrusters

On 25 February 2021, the captain received voyage instructions from the operations department for shipping the thrusters, including contract information relevant to the crew. Loading, lashing and unloading was to be carried out by the ship's crew using the ship's own material. The voyage instructions included the annotation that the gearboxes of the thrusters contained oil but that this oil did not constitute a hazard during transportation.

Annexes to the voyage instructions included the packing list for the thrusters, an example of the stowage plan[12] for the voyage Palermo – Ulsteinvik with only the thrusters plotted out, a photograph of a thruster and the technical specifications. The photograph of the thruster and the technical specifications were the same as provided by the freight broker to the chartering department.

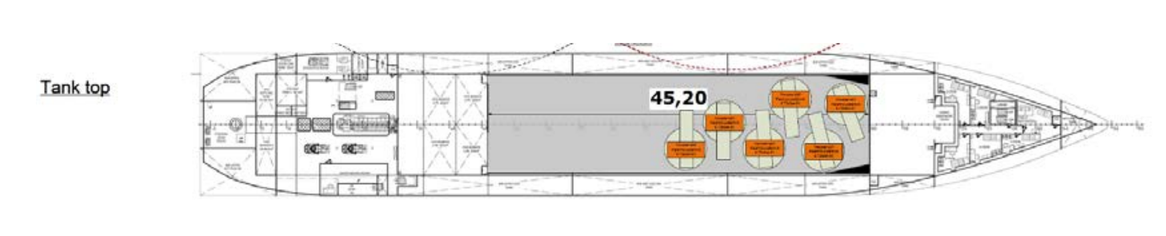


*Figure 15: The stowage plan as received by the captain and first officer from the operations department.*

*The stowage plan and lashing calculations*

Based on the information received on board, the first officer checked the stowage plan and revised it because of the other cargo already on board and the planned loading and unloading operations. After the crew change the relief first officer made a lashing calculation for the azimuth thrusters. The stowage plan and the lashing calculations were first checked by the captain and then forwarded to the operations department to be checked. For this lashing calculation, which was made prior to the lifting of the cargo, a value of zero was used for the CoG. The CoG as indicated on the drawing was not used.

In both the stowage plan at departure from Palermo and the stowage plan received by the captain and the first officer from the operations department, the thrusters were supposed to be loaded at the front of the hold with the gearboxes in lateral orientation. Since in every port of call cargo was loaded or unloaded, the stowage plan was revised in each port of call and also when new voyage instructions concerning cargo were received. For the purpose of checking the calculation by the third party, the thrusters were plotted out in a stowage plan with their position derived from the photographs (figure 16). This shows that the actual position of the thrusters in the hold did not correspond to the positions indicated in the stowage plan. The gearboxes of the thrusters on port side were oriented slightly forward and the gearboxes of the thrusters on starboard side were oriented slightly rearward.

12 A preconceived plan showing the order of loading and the location of cargo in the hold(s) or on deck.

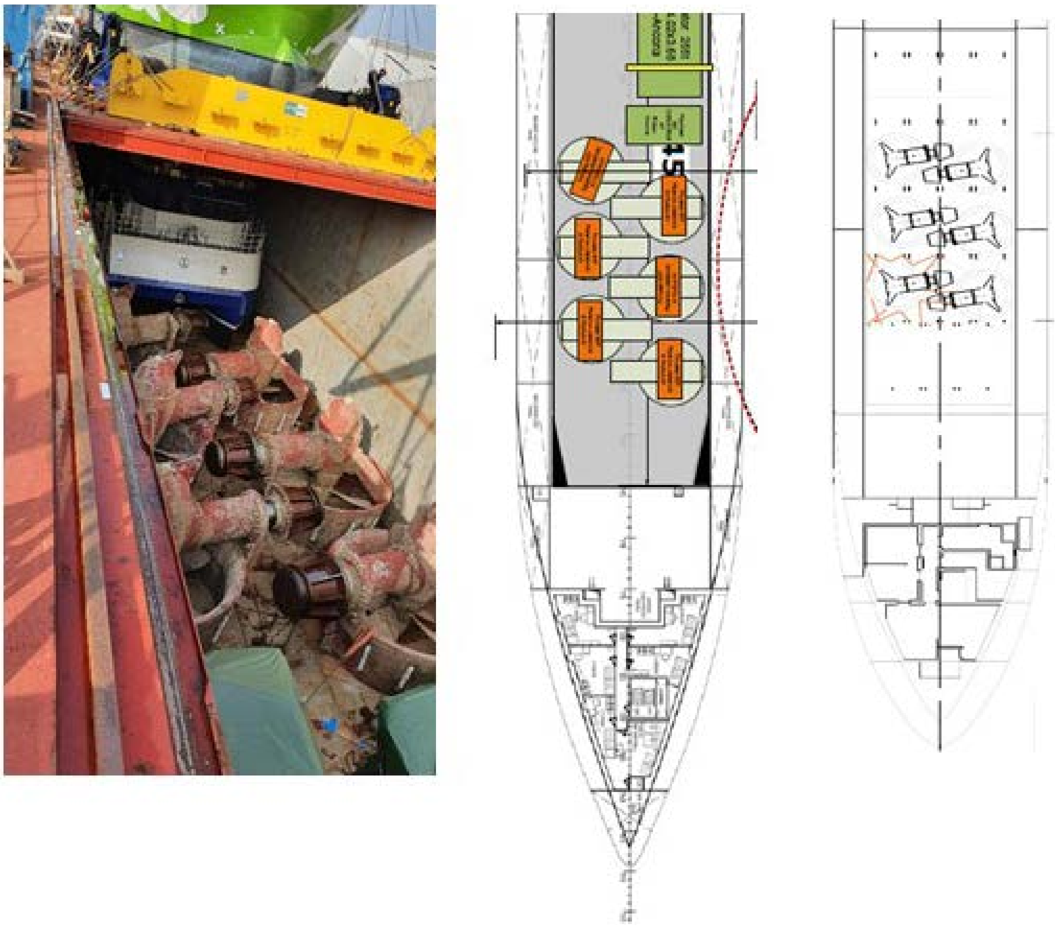

*Figure 16: The azimuth thrusters stowed and lashed in the hold after departure from Palermo and next to it the stowage plan as prepared on board and the stowage plan as prepared by a third party. (Source: Amasus and EVH Surveys)*

Experts stated that because the longitudinal accelerations of a vessel are smaller than the lateral accelerations it would be best practice to stow the thrusters with the gearbox pointing in longitudinal direction. The forces exerted on the lashings will then be smaller. By placing the thrusters longitudinally in the hold, it will also be easier to fix the lashings symmetrically. Because of the limited space in the hold and the presence of other cargo, the captain and relief first officer in this case opted for placing and lashing the thrusters transversely.

The relief first officer made the lashing calculations using a calculation tool that the operator had developed on the basis of an Excel. The calculation tool was based on the (CSS code) and calculated the required number of lashings in accordance with the alternative calculation method. It was also possible to use another tool for making lashing calculations, but the Excel tool mentioned above was the common tool used.

After the incident, a third company checked the formula, the ship's specifications and the accelerations in the Excel tool for general accuracy and the accuracy in relation to the CSS code. When checking the calculation there was only a small, negligible deviation from the CSS code. Any method for calculating the number of lashings is suitable as long as it can be determined if the lashing system is sufficient.

Calculations for lashing the cargo are made using a calculation tool based on CSS code annex 13. The advanced calculation method of Annex 13 is a calculation method that can be used to determine the effectiveness of the lashings with regard to shifting and tipping.

This calculation method is based on a balance of forces. The calculation is made for shifting and tipping longitudinally and transversely. A calculation is made for each side, but one calculation will suffice for both port and starboard (and front and aft) when using a symmetrical lashing system. The total load capacity (the sum of all lashings per side) must be greater than the forces exerted by the movements of the vessel. When calculating the load capacity, the horizontal and vertical angles of the lashings and the friction need to be included. A safety factor will also be applied. A lashing system will be effective when the load capacity of the lashings is greater than the forces created by the movements of the vessel.

Calculations can be made both at the office and on board, depending on the weight of the cargo item. Various calculation methods, all based on the same annex, are being used by operators as well as ship's crews.

For lashing the thrusters, the relief first officer made lashing calculations on two occasions: once prior to the lashing operations and once after the actual lashings had been installed. The second of these calculations was made to check whether the lashings had been installed correctly. In this calculation, the position of the cargo and the angles and lengths of the lashings were adjusted to reflect the actual situation. The calculations were based on the use of fourteen lashings.

When making both lashing calculations, the relief first officer used one single calculation which was then applied to all six thrusters. A weight of 52 tons was used instead of the 60 tons initially communicated by the freight broker. The 52 ton figure was the weight registered by the crane during lifting. In reality, the individual thrusters had not been lashed in the same way and therefore one lashing calculation should not have been applied to all six thrusters. In order to calculate the correct load capacity of the lashings, in this case, a separate calculation would need to be made for each individual thruster.

The report by the third party shows that the data entered by the relief first officer in both calculations was not fully consistent with the input data required for an accurate calculation in accordance with the method used. This can be found on page 7 in Appendix A.

There were deviations in the input for the position of the CoG of the thruster relative to the length and width of the footprint and the lever-arm of the lashing to the tipping point. The CoG entered by the relief first officer, differed from the theoretical CoG as indicated on the drawing of the azimuth thrusters. The CoG as indicated on the drawing was not used in the lashing calculations. The relief first officer used the CoG he had determined when the thrusters were lifted.

The inconsistencies in the input of the lever-arm caused the counter moment for tipping to be wrongly calculated. The input data did not reflect reality. Because the cargo data had been incorrectly entered in the calculation, the calculation was fundamentally wrong.

The results of both the initial lashing calculation and the verification calculation made by the relief first officer based on the entry data for angles and lengths of the lashings, indicated that theoretically the number of lashings calculated would be sufficient to counter the movements of the vessel in longitudinal, transverse and vertical directions. However, looking at the photographs (figure 17) it could be concluded that the lashings were not installed in accordance with the lashing calculations made by the relief first officer. The positions of the lashings, the angles and the lengths of the installed lashings did not correspond to the data entered in the calculation. The calculation was also based on a single type of lashing instead of a combination of materials. This caused other loads to be exerted on the lashings than had been anticipated.

*Figure 17: The thrusters on the port side and starboard side in the front part of the hold (Source: Amasus)*

Both lashing calculations made on board of the vessel were made by the relief first officer in consultation with the captain. These calculations were also sent to the operations department of the operator to be checked. During the various stages of observation, neither the captain nor the operations department noticed that the way in which the calculation was made and the entered data were not entirely correct.

The actual way of stowage of the cargo of azimuth thrusters was approximately in accordance with the stowage plan, but not entirely.

The way in which the crew had lashed the azimuth thrusters deviated from the structure of the lashing system in the calculations, causing the lashings to be exposed to other forces than anticipated. In addition, the calculation was made using inaccurate data causing it to be fundamentally incorrect.

When observing the calculations at the time they were made, neither the captain nor the operations department noticed that the entry data of the calculations did not correspond to the actual situation.

*Lashing the cargo*
The relief first officer made a plan for stowing and lashing the thrusters in the hold. In the hold, the relief first officer marked out the locations where the thrusters and the lashings needed to be placed and installed. The lashing plan was not recorded on paper, not before nor after loading was completed.

For each thruster on average fourteen lashings were used. One thruster had a lashing less, another one more, just what was convenient. The lashings consisted of lashing chains, in some cases combined with polyester slings and secured to D-rings on the tank top and the wall of the cargo hold (figure 18). These were fixed D-rings as well as twistlock D-rings and welded D-rings. The lashing chains and tensioners were between six months and three years old. The age of the polyester slings and welded D-rings could not be determined from the information available. The crew considered the condition of the lashing material to be adequate.

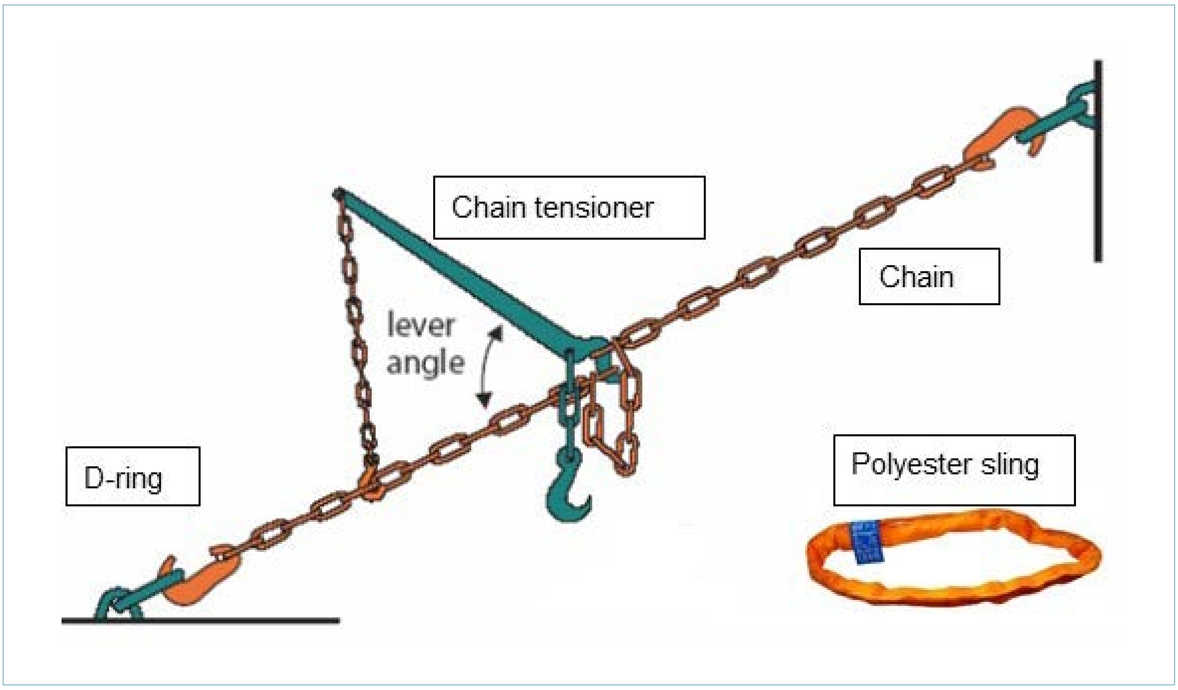


*Figure 18: Visual overview of the lashing material used for lashing the thrusters.*

For lashing operations the vessel carries its own ample supply of lashing material. This lashing material is certified from new and is inspected on board every three months by the crew in accordance with the CSM regulations. The inspection results are recorded in the maintenance system of the vessel. Prior to loading and lashing of cargo the crew inspects the lashing material visually as well.

A visual inspection may identify visually broken or damaged lashing material which subsequently needs to be kept separate. Since a visual inspection is not conclusive with regard to the actual condition of the lashing material, the lashing material on board was generally used for a few years. As the material is used in a salty environment, it starts to look corroded relatively quickly. The lashing material was replaced every few years. Lashing chains in poor condition may have a reduced load capacity. In merchant shipping this is a common method for using and checking a ship's own lashing material.

*Figure 19: A container with lashing chains and tensioners on board the vessel.*

The thrusters were not supported by cargo stoppers because no special stoppers were provided by the manufacturer. According to the operator, stoppers that were tailor made to fit the thruster would have been required for this type of cargo. The chartering department did not check with the broker if these special stoppers were available for the cargo of azimuth thrusters whereupon the captain and relief first officer agreed that the use of lashings alone would offer sufficient load capacity to prevent the cargo from shifting. The fact that welding in the port of Palermo was not permitted was an additional reason for not installing stoppers.

In absence of integrated D-rings in the cargo hold, a number of additional D-rings were welded onto the tank top. These D-rings were welded on the tank top by the boatswain who was in possession of a welding certificate. The positions of the D-rings and the thrusters were plotted out in the hold by the relief first officer. After completion, the welds were visually inspected by the relief first officer. Welding was carried out during the voyage to Palermo. This meant that the D-rings had already been installed before the thrusters were placed in the hold and therefore it was not possible to adapt the lashing system to deviations in the properties or the arrangement of the thrusters.

During the visual inspection no abnormalities were found in the welds, and after reviewing the photographs of the welded D-rings, experts confirmed that the welds looked fine. It was noted that the weld ran round the corner of the base of the D-ring, which indicated the weld had been made in a professional manner. Such a visual inspection can never completely confirm the quality and load capacity of a weld because of the superficial nature of the assessment, but it is unlikely that a badly welded D-ring caused the cargo to dislodge.

*Figure 20: One of the welded D-rings for securing the lashings of the thrusters.*

The thrusters were placed in the hold on several smaller pieces of plywood with a thickness of 1.5 cm. These plywood pieces provided friction between the thrusters and the deck. The photographs of the lashed thrusters show that the lashings were made in different configurations (figure 21).

The thrusters were almost stowed against the walls of the hold. This limited the options for attaching lashings and their orientation on that side of thrusters. As the thrusters in the hold were in slightly rotated position, it can be assumed that the lashings could not be attached symmetrically. A number of lashings was attached under a vertical angle of more than 60 degrees or almost 60 degrees and the lengths of the lashings differed. The lashing chains were also combined with polyester slings that in some instances were placed under large vertical angles across the edges of the nozzle.

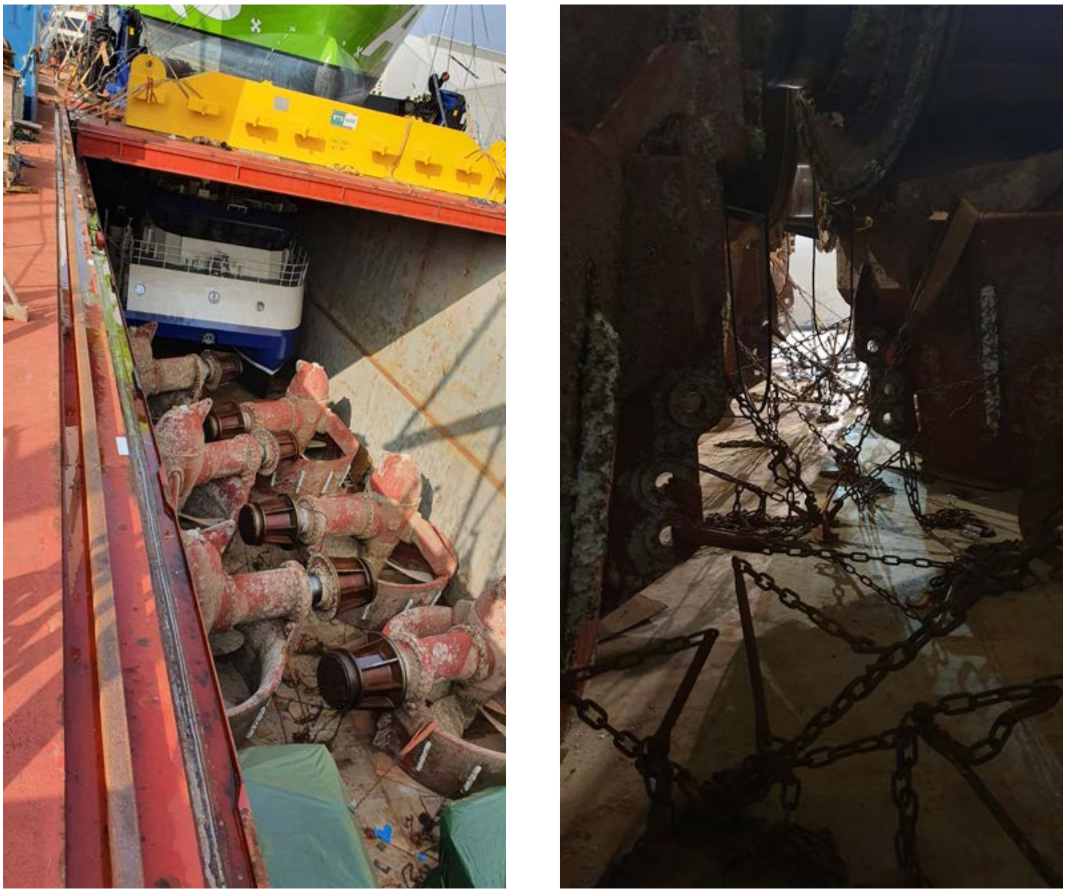

*Figure 21: The azimuth thrusters stowed and lashed in the hold. (Source: Amasus)*

The difference in elasticity of the materials has a negative effect on the effectiveness of the lashing system. For the same reason, large differences in length between the various lashings can also have an adverse effect. The difference in elasticity causes play which in turn causes lashings to become loose, generating jolts in the loads exerted on the lashings. Lashing chains in particular are prone to shock loads which may cause breakage. If there is a possible risk of cargo tipping over, the elasticity of the lashings in the vertical plane should also be taken into account. Because of the difference in elasticity, the pressure on the plywood on the deck could be significantly reduced, causing the plywood to slide away. In addition, the use of polyester slings at large vertical angles and across edges increases the risk of the slings being cut.

CSS code Annex 13 states that the vertical angle of lashings used for preventing the shifting of cargo may not be greater than 60 degrees. The horizontal angle may not be greater than 30 degrees. If the angle exceeds these limits, the lashing may not be included in the calculation for the required number of lashings to be used to prevent the cargo from shifting. However, these lashings will still be acceptable for the purpose of preventing the cargo from tipping over.

Within a lashing system, the greatest possible use should be made of one type of lashing material to prevent differences in elasticity. The CSS code compensates for differences in elasticity and the reduced load capacity of lashings by using a safety factor in the calculation method. The CSS code also states that despite the use of a safety factor, it is important to use lashings of the same material within a lashing system to prevent differences in elasticity.

After the thruster had been loaded and lashed on board, the lashing system was not checked by anyone but the ship's crew. The contract states that when the cargo consists of yachts, a load master appointed by the charter company needs to be present during loading, lashing and unloading of the yachts. Based on information in the *Heavy Lift and Project Cargo Manual,* it could be established that for other heavy cargoes a cargo superintendent has been appointed by the operator. For cargoes with a weight of less than 100 tons, there is no oversight. In such cases, the captain's guarantee that the cargo has been lashed properly is sufficient.

**Heavy Lift and Project Cargo Manual**
In this manual the operator introduces regulations, instructions and guidelines for the handling and stowing of project cargo, heavy cargo and general cargo, based on international regulations and recommendations, in particular the CSS code. It provides captains and officers of the fleet with technical guidelines for the handling, bedding and lashing of project cargo and other non-standard cargo. The manual provides information about all aspects of loading and securing cargo on the vessel. These rules apply to operations involving heavy cargo of which individual items weigh more than 100 tons.

Although this manual applies to cargo of which individual items weigh more than 100 tons, it also contains guidelines for smaller cargoes which are not mentioned in the CSM.

A cargosuperintendent was on board during the northbound voyage, when loading the green workboat and on the voyage from Bremerhaven to Kolvereid, port of discharge of the green workboat. He was on board because loading and unloading of the green workboat happened with a tandemlift of more than 100 tons. The lift approached the maximum Safe Working Load (SWL) of the cranes and lifting materials. His job was also to provide guidance to the relief first officer during loading and unloading of the workboat, since the first officer was on his first trip in this role. It was also the first trip for the captain in his new role.

Discussions with the operator made clear that thruster were shipped more often and that the office staff had ample experience in this field. One southbound voyage carrying a similar cargo of thrusters was mentioned specifically, and in that case cargo stoppers had been used to absorb sliding forces. At no time in the process was the experience of either the office staff or the cargosuperintendent used.

The outcomes of the lashing calculations were sufficient in theory, but in reality the lashing system was not effective. The azimuth thrusters in the hold were not symmetrically lashed by the ship's crew, which also meant that in some instances the prescribed angles of the lashings were exceeded. Cargo stoppers were not used. Using lashing chains in combination with polyester slings caused differences in elasticity which had an adverse effect on the effectiveness of the lashing system.

The operator had no control mechanism in place for making sure the azimuth thrusters were actually lashed in full accordance with the lashing plan. The operator employs staff with ample knowledge of and experience in loading and lashing general cargo and azimuth thrusters. The operator did not share this knowledge and experience (pro) actively with the captain and the relief first officer. Therefore, this knowledge and experience were not fully utilised.

# 5 CONCLUSIONS

On 5 April 2021, the Dutch cargo vessel Eemslift Hendrika ran into difficulties off the coast of Norway during a northwestern storm. During the voyage a number of azimuth thrusters in the cargo hold shifted and punctured three of the ship's tanks for ballast water. The water then flowed from the ballast tanks into the cargo hold. As a result of the ballast water leaking into the hold and the shifting cargo, the vessel developed a starboard list to such an extent that it became an emergency and the crew had to be evacuated.

The Board wanted to know what caused the cargo of azimuth thrusters to become dislodged. Based on this investigation the Board concludes that the lashing system in the hold was not sufficient under the prevailing conditions.

When the relief captain decided to take the route across open water, contradicting the advice of the owner, he pushed the margins of safe navigation. Due to the deteriorating weather conditions it became impossible to maintain course and speed and the vessel had to ride out the storm.

The lashing system could not withstand these circumstances and failed. The actual set up of the lashing system in the hold was not in accordance with the plan. This meant that the calculated forces were different than the actual forces exerted on the lashings. The lashings were made up of different materials and showed variations in length. This caused the lashing system to have differences in elasticity. Also, the angles at which the lashings were installed exceeded the angles as prescribed by the industry standards.

**The underlying factors that contributed to the occurrence**

*Weather forecast*
The weather predictions were such that the captain did not perceive the route across open water as an immediate danger. With his decision, he approached the margins of safe navigation, trusting that the azimuth thrusters were properly secured. The ship could withstand the conditions but the cargo appeared to be lashed insufficiently to cope with the consequences of the northwesterly storm and sea conditions. Safer alternatives to the route across open sea were not utilised.

The owner advised the captain to choose a route across inland waters, but this was merely an advise and not a direct order and there were no fixed limits to be adhered to. Principally, the good seamanship of the captain was relied on.

*Knowledge and experience*
The operator failed to (pro)actively pass on knowledge and experience in the field of shipping azimuth thrusters. The experience of the operator in shipping azimuth thrusters and the use of cargo stoppers was not (pro)actively shared. In addition, both the relief first officer and captain were new in their role. During preparation as well as during execution of the lashing operations, the control mechanism did not function.

*Sharing information*
Information essential for the safe transportation of the cargo of azimuth thrusters was insufficiently shared between the relevant parties. The information received by the operations department from the freight broker and that was passed on to the captain and first officer was not complete and not sufficient to enable the crew to lash the azimuth thrusters properly. The discrepancy between the information available and the information required, combined with the transverse positioning of the azimuth thrusters, made it difficult to devise a symmetrical and effective lashing system.

*Lashing the cargo*
During preparations, the stowage plan was approximately in accordance with the actual situation, but not entirely. The results of the lashing calculations showed that theoretically a sufficient number of lashings had been installed. However, as the calculations were made using inaccurate data, they were fundamentally incorrect. The lashing system as installed by the first officer was not in accordance with the calculations and the applicable standards, which resulted in a reduction in the capacity of the lashing system. Cargo stoppers were not used when lashing the azimuth thrusters.

The check the captain and operator performed of the stowage plan and lashing calculations did not reveal the errors in the plan and the calculations. The lashing system was insufficiently checked by the captain to ensure the system was effectively set up and matched the plan. There was no check done by the operator on the execution of the lashing system and the results.

# 6 RECOMMENDATIONS

The perception among a part of the industry that a captain cannot receive instructions has historically grown. Traditionally, a captain was dependent on himself and his crew during sea voyages. In the present time, shore communication with ships has improved and there is regular contact between the office and the ship. This allows an operator or ship owner to give instructions if a situation requires it. The Dutch Safety Board therefore issues the following recommendation.

*To the operator Amasus:*

1. As a company and owner of ships, in exceptional situations where the safety of the crew and the ship is or is likely to be compromised, use the possibility of imposing instructions on the captain.

Shipping of cargo is a process that consists of a number of fundamental or conditional steps. Each of these steps involves one or more parties who play a certain role in the process. This incident has shown that it is important for all parties involved to draw each other's attention to unusual characteristics of a cargo, as is already prescribed for heavy lifts, even if it does not fall into the category of a 'heavy lift'. To promote this, the Dutch Safety Board issues the following recommendations.

*To the operator Amasus:*

2. Ensure that the stowage and lashing of unusual cargo, i.e. cargo with an eccentric centre of gravity or abnormal shape, can be carried out on board in such a way that reality is in accordance with the plan. This incident shows that when drawing up a plan that is feasible in practice, attention should be paid to at least the following topics:
    a. Making demonstrable use of the existing knowledge and experience of shipping unusual cargo that is present in the company and its employees.
    b. Using input data for the lashing calculations that are accurate and in accordance with reality.
    c. Requesting all necessary information for the shipping of cargo and sharing this with the crew.

3. If the original lashing plan is deviated from, check whether the changed method of stowing and/or lashing is sufficient to be able to transport the cargo safely.

# APPENDIX A

## REPORT EVH SURVEYS

### Report S21-11 05238 for the Dutch Safety Board on Dislodging and Shifting of Cargo on Board MS Eemslift Hendrika on 5 April 2021 – Revision 1

This report was ordered by the Board. The author of the report, EVH Surveys, agreed to the publication of the report as an appendix to the investigative report.

The assignment consists of two parts, namely:

1. Checking the programme that the operator used to make the lashing calculations. On board of its ships the operator used an Excel-file for calculating the number of lashings for cargo. This Excel-file is based on the CSS code, but the Board would like to have it tested for general correctness and correctness in relation to the CSS code.
2. A number of lashing calculations for the six azimuth thrusters.

When performing the calculations, EVH surveys used the initially indicated weight of 60 tons instead of the 52 tons as read by the crane operator. This difference did not have any effect on the conclusions, as the calculation results showed that theoretically a sufficient number of lashings were fitted. This would also have been the case if the weight had been lower.

# APPENDIX B

## RESPONSES TO THE DRAFT REPORT

Pursuant to the Dutch Safety Board Act, a draft version of this report was submitted to the various stakeholders. The following parties were asked to check the report for factual inaccuracies and inconsistencies:

- Operator Amasus Shipping
- Owner Eemslift Hendrika
- Relief captain, individually
- Captain, individually
- Cargosuperintendent individually
- Relief first officer, individually

The Safety Board received a combined response of the owner of the vessel, two regular captains of the vessel and a cargosuperintendent of Amasus. The stakeholders did not wish to reply individually. An individual response was received from the relief first officer.

The relief captain did not send a response.

The responses were dealt with in the following manner:

- Rectifications of factual inaccuracies, additions at detail level and editorial comments were adopted by the Safety Board (wherever relevant). The appropriate sections of text have been adjusted in the final report;
- The structure and tone throughout the report were adjusted to stay clear of the appearance of apportioning blame;
- Wherever the Dutch Safety Board did not adopt the content of reactions, an explanation is given as to why the Board made that decision.

All responses and the explanatory notes appear in a table that can be accessed via the website of the Dutch Safety Board (www.safetyboard.nl).

# APPENDIX C

## VESSEL DATA

| Vessel data | Eemslift Hendrika |
|---|---|
| **Photograph:** |  *Figure 22: Eemslift Hendrika (source: M. Witte)* |
| **Call sign:** | PCYX |
| **IMO number:** | 9671486 |
| **Flag state:** | The Netherlands |
| **Type of ship:** | General Cargo/Multi-Purpose |
| **Classification society:** | Bureau Veritas |
| **Year of construction:** | 2014 |
| **Shipyard:** | Partner Stocznia Sp .z.o.o |
| **Length overall (Loa):** | 111.70 m. |
| **Length between perpendiculars (Lpp):** | 102.00 m. |
| **Breadth:** | 16.80 m. |
| **Depth:** | 9.30 m. |
| **Gross Tonnage:** | 5460 GT |
| **Engine:** | MAK |
| **Propulsion:** | one propeller, one bow thruster |
| **Maximum propulsion capacity:** | 4000 kW |
| **Maximum speed:** | 17 knots |
| **Vessel certificates:** | All valid |

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