



# DMAIB

DANISH MARITIME ACCIDENT  
INVESTIGATION BOARD



# KARIN HØJ

Marine accident report on occupational accident

9 MAY 2019

**MARINE ACCIDENT REPORT ON THE OCCUPATIONAL  
ACCIDENT ON KARIN HØJ ON 9 MAY 2019**

published by

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Danish Maritime Accident  
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Carl Jacobsens Vej 29  
DK-2500 Valby  
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Photo: KARIN HØJ  
Source: DMAIB

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## Board statement

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On 9 May 2019, a first mate was trapped by a cardan shaft aboard the construction ship KARIN HØJ, while she was in the process of replacing a hydraulic hose on the ship's propulsion system. The first mate perished as a result of her injuries. The ship was in Eemshaven, the Netherlands, when the accident occurred.

The Danish Maritime Accident Investigation Board was informed of the accident on 9 May 2019. Due to the seriousness of the accident, the Investigation Board initiated an investigation on the ship on 10 May 2019, while it was at berth in the Netherlands. The purpose of the investigation was to answer two questions:

- What technical circumstances caused the cardan shaft to lower, trapping the first mate?
- What circumstances caused the first mate to bring herself in a situation where there was an imminent danger of being crushed?

During the repair of the ship propulsion system, the first mate disassembled the hydraulic hose connected to the lifting cylinder of a cardan shaft. When the hydraulic hose was dismantled, the hydraulic pressure in the lifting cylinder immediately disappeared, and the cardan shaft sank down over the first mate.

On board KARIN HØJ, it was normal working practice for the first mate and the master to perform maintenance and minor repairs on machine installations, either alone or following instructions from the technical department of the company. No formal risk assessment was carried out before beginning the work, but as the crew did not possess formal mechanical engineering skills, they could not in reality assess the risk conditions.

On 9 May 2019, the ship's maintenance and repair practice thus led to the ship's first mate being crushed by the cardan shaft in the ship's starboard engine compartment and perishing, while working on the replacement of hydraulic hoses.

# Narrative

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The accident narrative spans the time from KARIN HØJ operated at a dredging area off Eemshaven until it arrived at Eemshaven on Thursday afternoon of 9 May, where the master found the first mate lying trapped in the ship's starboard engine compartment.

The course of events is described from the master's perspective and is based on a number of different data sources. There were no eyewitnesses to the incident itself.

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# Background

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Figure 1: KARIN HØJ  
Source: DMAIB, 2019

Persons on board KARIN HØJ was a split barge equipped with two Schottel propulsion systems, built in 1977 for transporting excavated material (figure 1). The ship had been continuously refurbished and was acquired by the shipping company Rederiet Høj in 2015. The ship was registered in Horsens. It primarily operated loading excavated material from other ships.

At the time of the accident KARIN HØJ loaded excavated material from other ships, who dredged in an area northwest of Eemshaven, and unloading the excavated material at a disposal site in open waters. The ship was manned by a master and a first mate. The master held a certificate of competency as master for vessels less than 500 GT and the first mate held a certificate of competency as Mate, 4th class.

The master had ten years of experience as a mate and master on various ship types. He had sailed as a first mate and master for Rederiet Høj for seven months. The first mate had 13 years of experience as a first mate on smaller tugs, of which the last 13 months were as a first mate with Rederiet Høj.

On 9 May 2019, KARIN HØJ was positioned at Ems near Eemshaven in the Netherlands. As a subcontractor, the ship was carrying out work for a construction company and tasked with loading excavated material and transporting it to a disposal site in open waters. During the assignment, KARIN HØJ was based at the port in Eemshaven (figure 2).

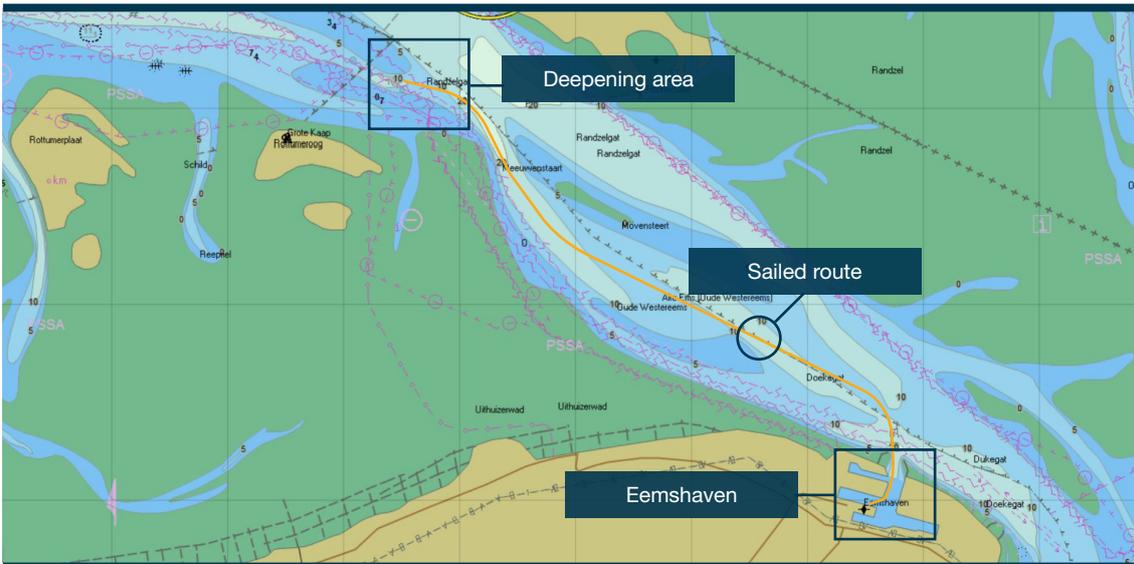


Figure 2: The deepening area and the route to Eemshaven  
 Source: © Made Smart Group BV 2016, C-Map data © Jeppesen AS /DMAIB, 2019

## Course of events

During a loading operation in a deepening area on 9 May 2019, KARIN HØJ suffered damage to hydraulic hoses controlling the aft port side propeller, which led to the ship having only one propeller available. After being towed away from the deepening area, the ship attempted to get itself to quay. In the attempt, the ship hit the quay with the stern, this time damaging hydraulic hoses controlling the starboard propeller, which meant that the crew lost control of the ship.

The first mate, who went to the aft deck during the unsuccessful attempt to get the ship to quay, noticed that hydraulic oil was leaking from the damaged hydraulic hose on the starboard engine and immediately alerted the master on the bridge. The master quickly stopped the engine to prevent oil from spilling into the port. The ship had its aft end towards the quay, and the master found that it was necessary to get out of this situation as soon as possible, because the ship was in danger of further damaging its engines and propellers. The master thus immediately rang the ship's agent and ordered a tug, which could bring the ship safely to berth. Meanwhile, the first mate had started collecting the hydraulic oil spilled on the aft deck (figure 3).

Shortly after the master had called for tugboat assistance, he walked down to the deck to see how severe things were with the ship's engines. The first mate, who was busy with cleaning up the oil, asked the master to fetch the oil absorbent granules from under the foredeck at the bow of the ship, so the remaining oil could be absorbed.

When he returned with the granules, they had a short exchange of words about how to deal with the situation. The master focused on getting tugboat assistance as quickly as possible, while the first mate was working to repair the oil leak and change the damaged hoses.

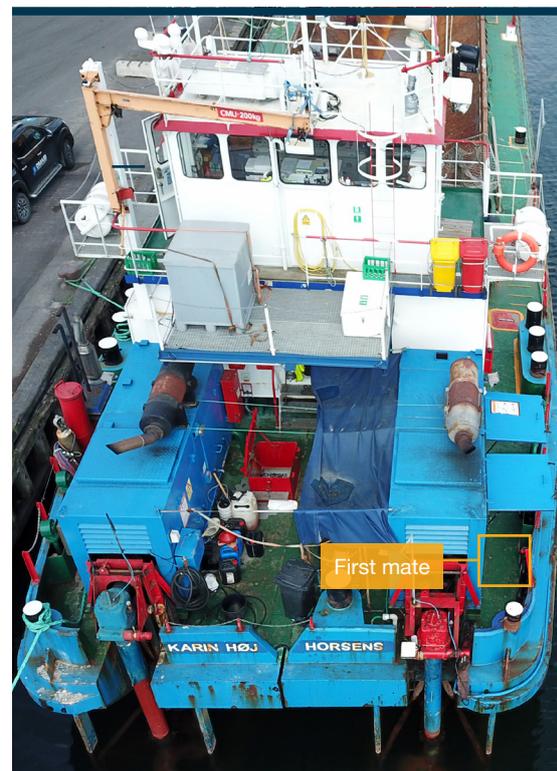


Figure 3: The first mate's location on the aft deck  
 Source: DMAIB, 2019

The master returned to the bridge to get a status from the ship's agent on the arrival of the tugboat. The agent explained that there was an hour's wait on the tugboat. The master returned to the first mate on the aft deck. The mate had started to change the hydraulic hoses on the actuator and had passed the first hose under the shield to the starboard engine (figure 4).

At the collision with the quay, most of the oil had leaked out of the hydraulic system, and the first mate thus asked the master to pick up more oil under the foredeck. After fetching the oil for the hydraulic system, he returned to the bridge to inquire with the ship's agent with regard to the tugboat. Before he got to calling the agent, he heard a cry from the aft deck. He quickly rushed down to the aft deck, where he found the first mate in the engine compartment trapped under the cardan shaft (figure 5).

The master immediately searched for tools that could help him release the first mate. In the ship's generator room he found a strap and a chain hoist with which he tried to lift the cardan shaft, but it was impossible. He rushed to call the ship's agent, to get him to arrange for an ambulance, while at the same time he got hold of some people on the quay, who could help him. A forklift truck and several crew members from the nearby ships hurried to the rescue. The forklift succeeded in lifting the cardan shaft, so the master and a mate from a nearby ship could mount a shearbolt, so the cardan shaft was secured against lowering. When the shaft was raised and secured, the first mate was free of the shaft weight, but there was not enough room for the rescue team to get the first mate out of the engine compartment.

Therefore, a cooler had to be dismantled before the rescue team could free the first mate and get her on a stretcher. The rescue team ascertained that the injured first mate did not show signs of life. She was quickly carried ashore and brought to the nearby hospital, where a doctor declared her dead.

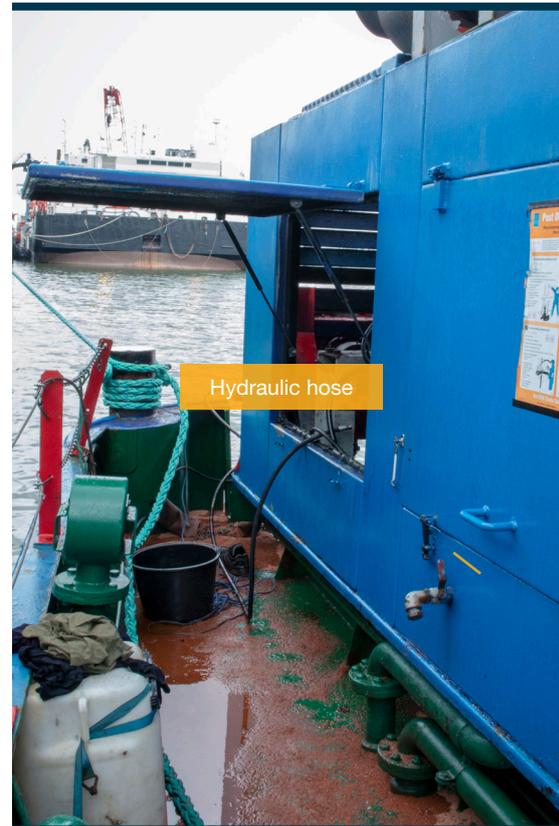


Figure 4: Access to starboard engine  
Source: DMAIB, 2019

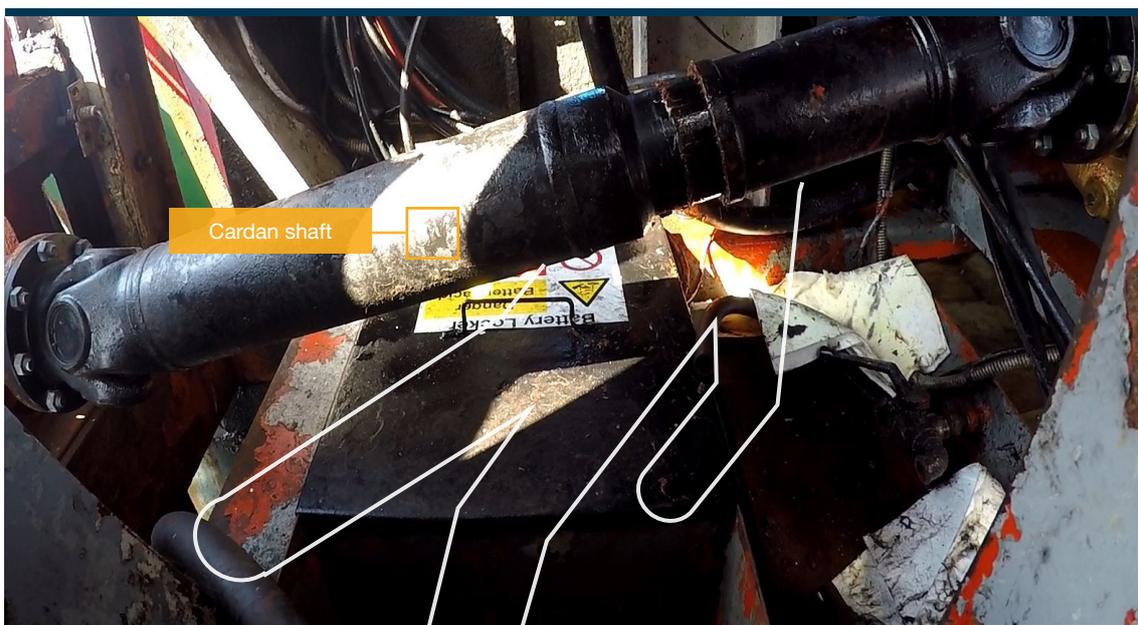


Figure 5: Outline of how the mate was caught under the cardan shaft for starboard engine.  
Source: DMAIB, 2019

# Investigation

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The purpose of the investigation was to identify the circumstances which led to a crew member's perishing in the course of repairing the ship's propulsion system.

The following sections describe factual circumstances that DMAIB has found relevant to uncover in the understanding of the incident.

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DMAIB was informed of the accident on KARIN HØJ on 9 May 2019. Two accident investigators were sent to Eemshaven, where an investigation onboard the ship took place on 10 May 2019. In addition, information was gathered from the Dutch authorities, such as surveillance images from the port, police reports, inquest documents, etc.

The purpose of the investigation was to clarify the course of events of the incident and to answer the following questions:

- What technical circumstances caused the

- cardan shaft to lower, trapping the first mate?
- What circumstances caused the first mate to bring herself in a situation where there was an imminent danger of being crushed?

In order to answer these questions, the investigation has found it appropriate to clarify a number of different issues, such as the propulsion system, manning, ship maintenance and the operation of the ship.

## Investigation of the site of the accident

In connection with the investigation of the scene of the accident, the investigation board found some of the equipment and objects used by the first mate in connection with the repair of hydraulic components in the starboard engine compartment. At the bottom of the engine compartment, close to the battery box, the wrench used for the repair was found (figure 6). The distance between the jaws on the wrench was the same span as the converter of the hydraulic hose and can therefore be considered highly likely to have been the one used by the first mate for the work. No other tools were found inside the engine compartment.

In the engine compartment it was found that the damaged hoses which had to be replaced were still fitted to the hydraulic valves. It was also found that the hydraulic hose connected to the lifting cylinder of the cardan shaft was dismantled (figure 7, next page).

On the actuator situated aft on the ship's starboard side, the investigation board found a hydraulic hose which had been changed and brought into the engine compartment, but not yet attached to the valve (figure 8, next page).

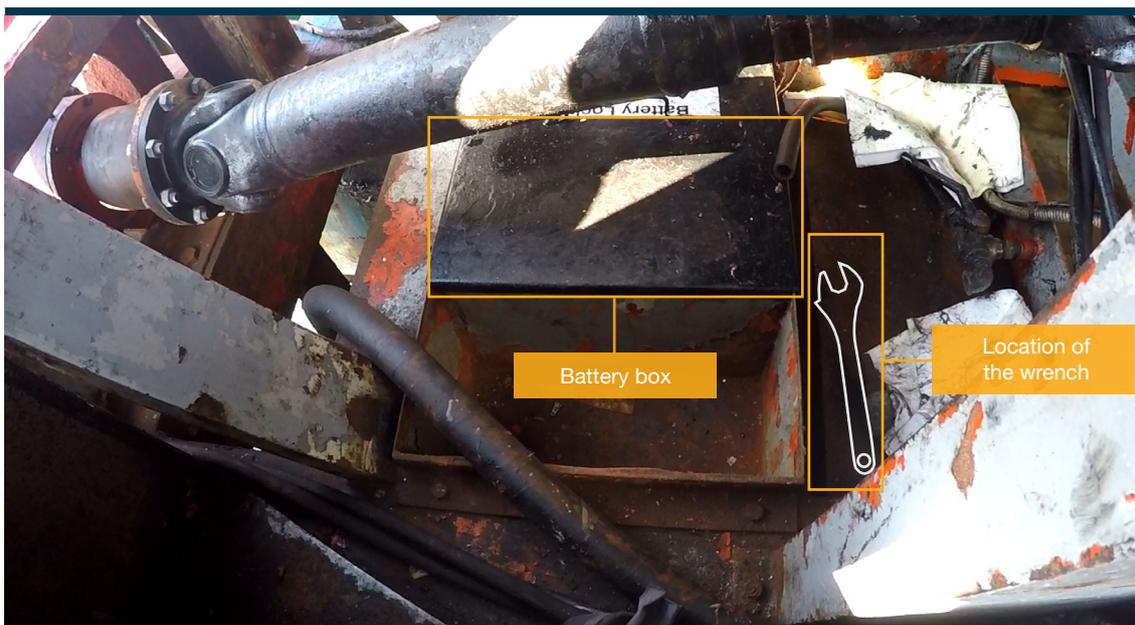


Figure 6: Wrench found between the motor foundation and the battery box  
Source: DMAIB, 2019

It can thus be found that the mate had begun work on the replacement of the damaged hoses from the hydraulic actuator on the ship's starboard engine. Hydraulic oil cans were also found, which had been used to refill the system after the leak.

A review of the inquest reports and imagery confirms that the mate perished as a result of the injuries she suffered when the shaft was lowered over her.

When the scene of the incident was investigated, the cardan shaft had been lifted to the upper horizontal position with the shearbolt mounted. The chain hoist and lifting strap used by the master in his attempt to lift the cardan shaft were also fitted.

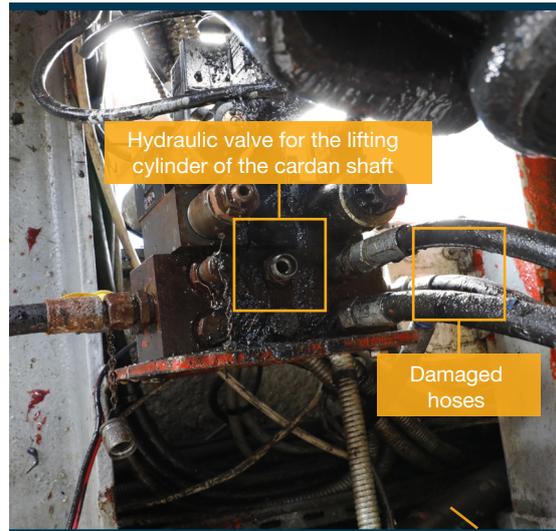


Figure 7: The hydraulic valves in the engine compartment  
Source: DMAIB, 2019

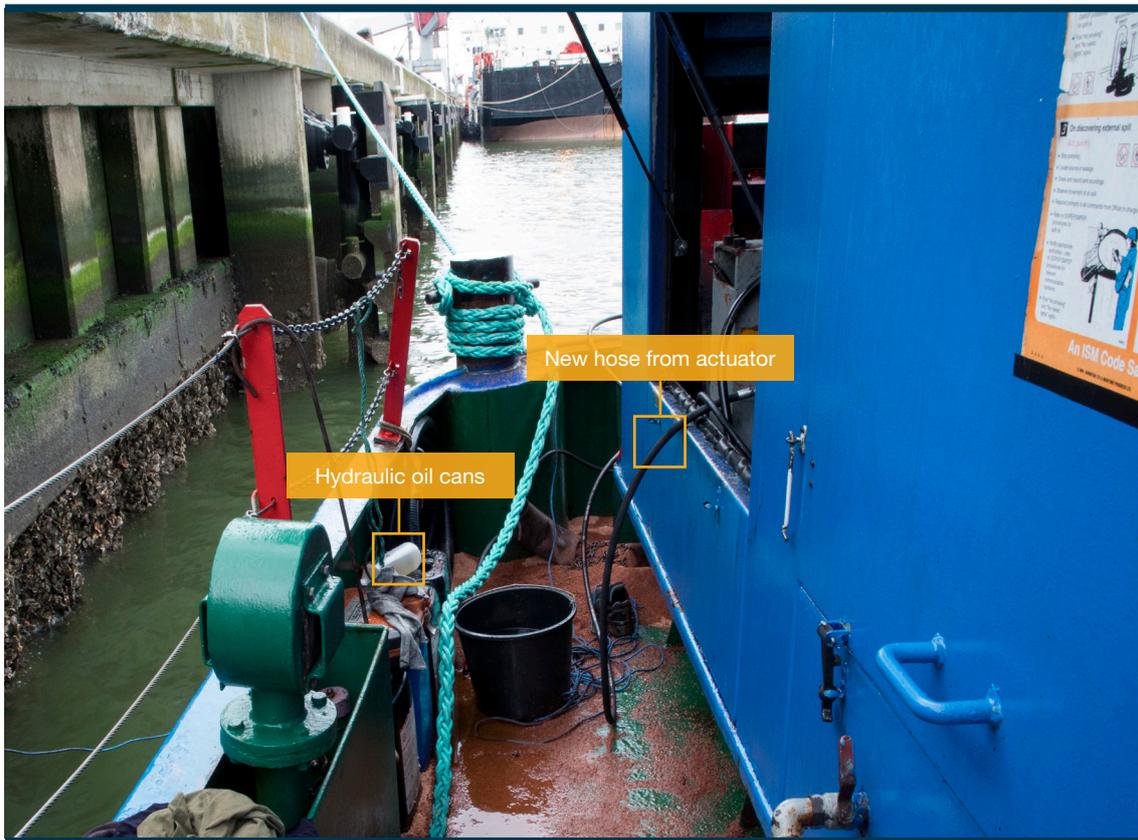


Figure 8: Entrance to starboard engine compartment  
Source: DMAIB, 2019

# The engine compartment

The ship was equipped with two Schottel propulsion systems, one on each side of the ship. Each propeller was powered by a diesel engine via a cardan shaft located in an engine compartment on deck and a vertical propeller shaft (figure 9). Access to the engine compartment and the cardan shafts was afforded on both the port and starboard sides of the engine compartments.

In the engine compartments on both the starboard and port sides there was, in addition to the diesel engines, a cardan shaft, a hydraulic valve battery and a battery box. The propeller shafts were driven up and down by the cardan shaft in the engine compartment (figure 10).

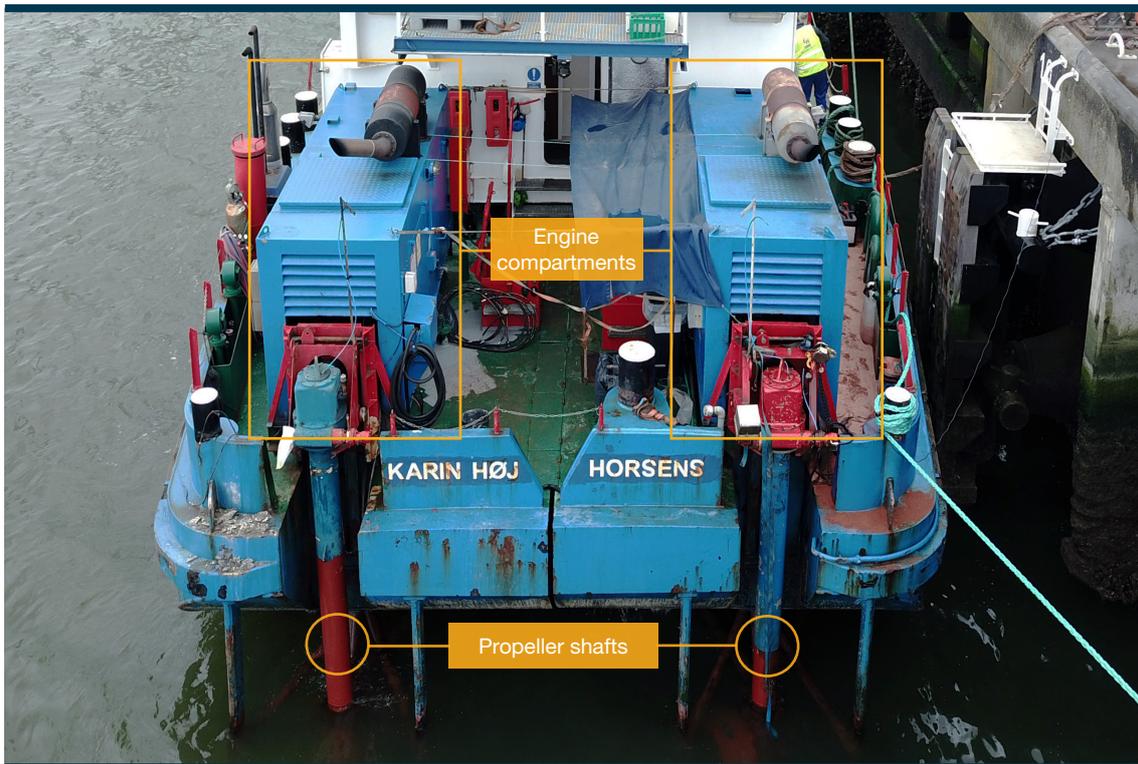


Figure 9: Propulsion engines and propeller shafts.  
Source: DMAIB, 2019

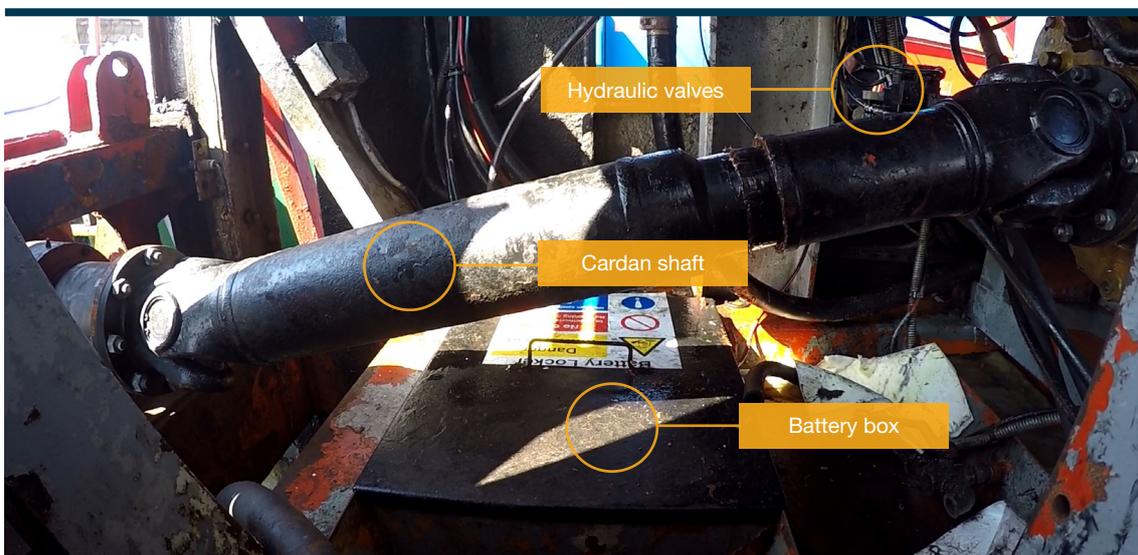


Figure 10: The engine compartment on the starboard side seen through the starboard hatch.  
Source: DMAIB, 2019

The cardan shaft was controlled via hydraulic valves which were designed to control the hydraulic piston that raised and lowered the propellers, so the ship could be operated in shallow water without damaging the propellers and in deeper water as well (figure 11).

The hydraulic valves operated both as a control unit for the hydraulic piston, which lifted and lowered the cardan shaft, as well as a steering unit for an actuator that turned the propeller shaft (figure 12). From the hydraulic valves several hydraulic hoses were passed out through the engine compartment to the

hydraulic piston and actuator respectively. DMAIB's investigation into the hydraulic system showed that it could be difficult to follow the connection between the hydraulic hoses from the hydraulic piston and the actuator to the valve battery, because the hoses were passed through a sock made of fire hose. The function of the sock was to protect the hoses on deck against wear.

In the engine compartment, the system components were mounted close to one another, which could somewhat complicate access to them when inspecting or replacing hydraulic hoses, etc.

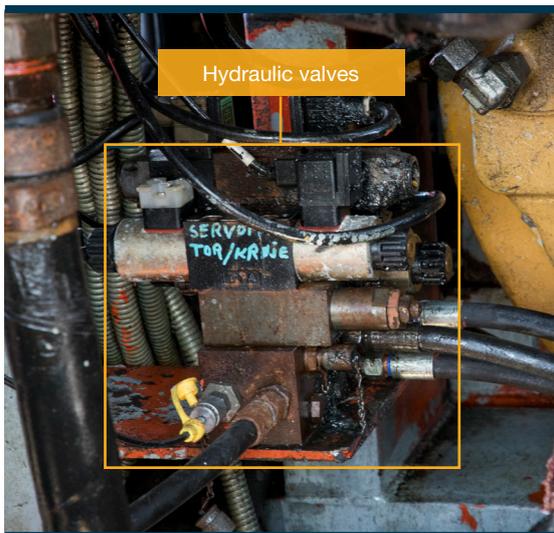


Figure 11: Hydraulic valves  
Source: DMAIB, 2019

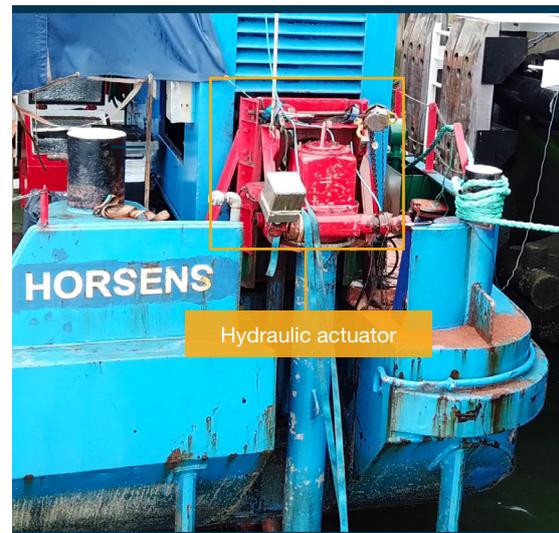


Figure 12: Hydraulic actuator starboard  
Source: DMAIB, 2019

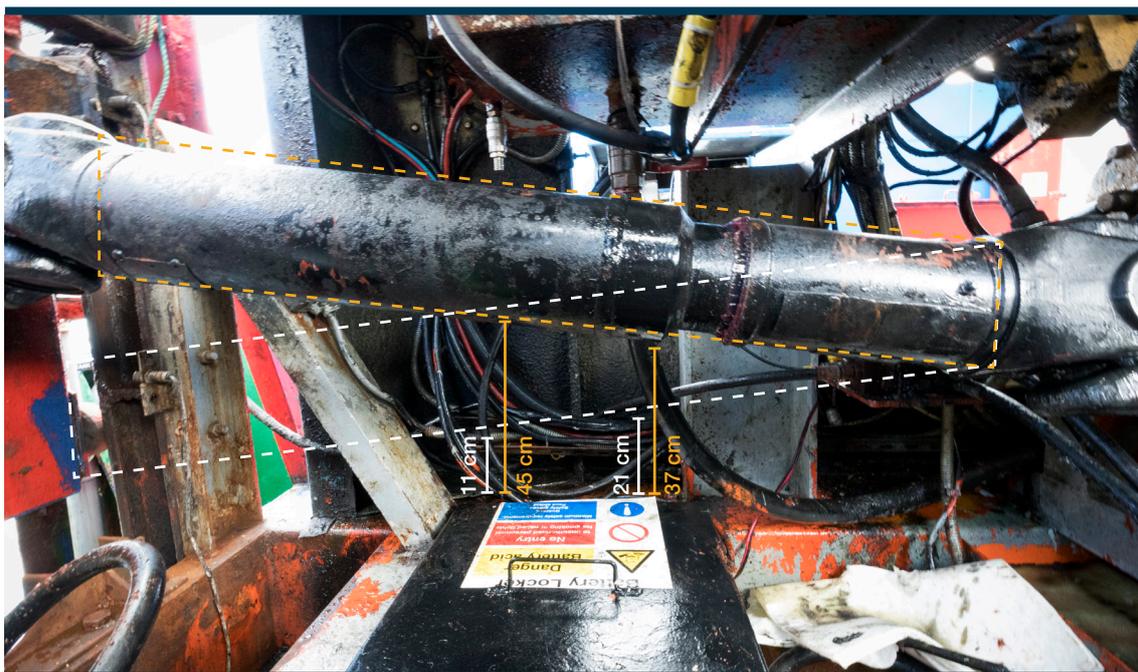


Figure 13: Distances between the cardan shaft and the battery box in elevated condition (yellow) and lowered condition (white)  
Source: DMAIB, 2019

The spacing in the engine compartment is shown in figures 13 (previous page) and 14. Between the battery compartment and the cardan shaft, there was a clearance of 11 cm, when the shaft was lowered, and 45 cm, when the shaft was raised. From the hatch in the engine compartment to the position of the valves, there was a distance of 145 cm. There was no access to the hydraulic valves, the battery compartment or the bodywork from any place other than the hatch on the starboard side.

The hydraulic hoses were mounted on the valves at such a close distance that it could be difficult to dismantle the individual hoses with a wrench (figure 15). In the picture, the wrench is placed on the hydraulic hose which caused the cardan shaft to lower. It may well be the natural choice to dismantle this hose in order to access the other hoses that were damaged.

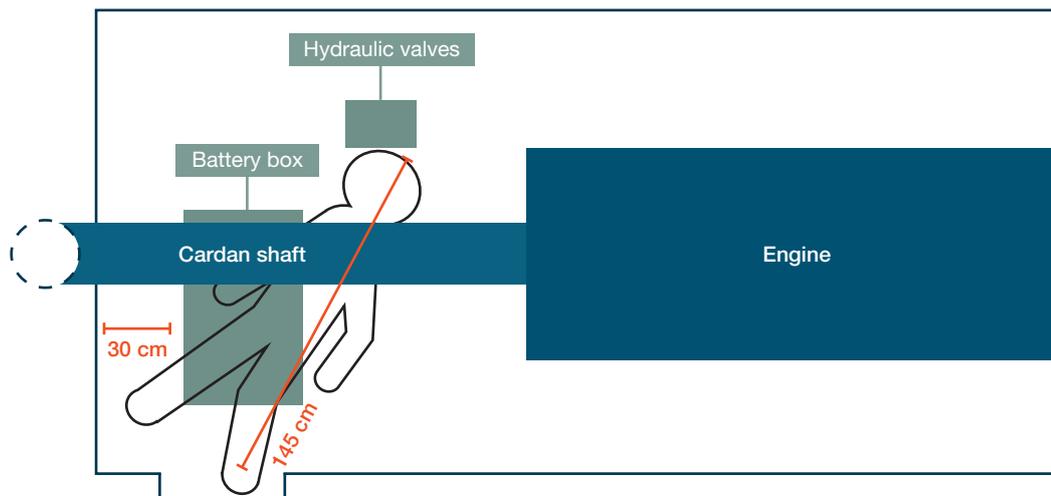


Figure 14: Distances between various system components in the starboard engine compartment.  
Source: DMAIB, 2019

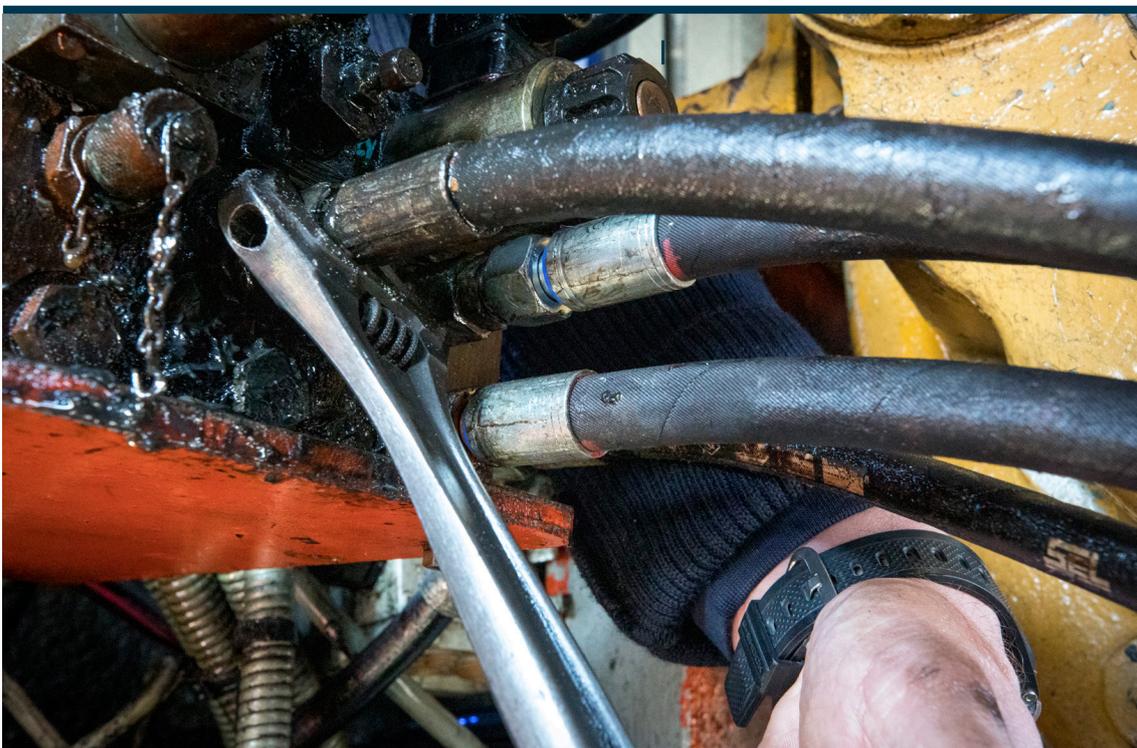


Figure 15: The wrench on the hydraulic hose, reconstruction  
Source: DMAIB, 2019

# Manning

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The maritime authority's requirements for manning for coastal voyages under the trading permit for KARIN HØJ were as follows:

A master holding a certificate as master (home trade)

A mate holding a certificate as mate, 4th class.

Two ordinary ship's assistants, both of whom fit for lookout duty and possessing watch keeping certificates, were only required when the daily voyage exceeded 14 hours.

At least one of the deck officers should be in possession of a radio certificate in GMDSS (ROC). At least one of the crew members should be in possession of a certificate of competency in motor operation providing them with basic knowledge of:

- Main diesel engine parts
- Knowledge of start-up, operation of the engine during passage and stopping the engine
- An understanding of diesel engine electrical systems
- An understanding of the servicing of a diesel engine
- Knowledge of measures to prevent fire and to operate fire-fighting and bilging equipment;
- Knowledge of measures to avoid pollution of the marine environment.

The certificate does not provide knowledge about working with hydraulic systems. This permit enables you to have an overall understanding of mechanical

engineering, but does not qualify you to make more complicated repairs to the ship's machinery.

To be able to carry out the tasks on KARIN HØJ, it was necessary for one of the crew members to have a certificate of proficiency in motor operation, as there was no demand for specific engine manning in the manning requirements.

On board KARIN HØJ on the day in question were the following crew members:

- Master: 55 years, certificate as master (home trade) and a certificate of proficiency in motor operation, 10 years of experience at sea. Had sailed as a master on KARIN HØJ for 7 months.
- First mate: 36 years, certificate as mate, 4th class and a certificate of proficiency in motor operation, 13 years of experience at sea. Had sailed as a first mate on KARIN HØJ for 13 months.

Since KARIN HØJ was not in passage for more than 14 hours, there were no ship's assistants on board at the time of the accident.

The first mate on KARIN HØJ had her mechanical engineering skills from her certificate of proficiency in motor operation, and it was she who, in collaboration with the master, handled the tasks of operating and maintaining the engine.

# Ship maintenance

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According to the company's safety management system, the shipping company indicates that the following activities are considered safety-critical:

*"Important operations on board are those operations where an error can immediately cause an accident or a situation that may be a threat to persons, the environment or the ship. Important operations on board can be further classified as important routine operations or important non-routine operations."*

As an example of important non-routine operations, the company indicates the following: *"Critical/special engine operations"*. At the time of the accident,

there were no risk assessments and/or procedures for the work on board the company's ships concerning the repair or replacement of mechanical engineering installations.

However, the company did have a procedure for *"important non-routine operations"* for which no risk assessment had been prepared. The procedure instructed employees to draw up a risk assessment prior to beginning the work and to prepare a new procedure for the execution of the work. A work permit should also be issued to be signed by the ship's master or first mate and subsequently forwarded to the shipping company.

## Operation of the ship

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KARIN HØJ had the primary task of receiving, shipping and unloading material from a dredging vessel. The ship worked with the company's own dredgers or with other ships from the company's partners.

The loading of KARIN HØJ was typically done by the master placing the ship alongside a dredging vessel, mooring it and then receiving the excavated material from the dredging vessel. When the ship was fully loaded, the master sailed the ship to a disposal site with the material, where it was unloaded.

A significant part of the crew's skills was being able to manoeuvre the ship to and from another ship in various weather conditions, because this ensured that the ship's capacity was fully exploited. Being able to manoeuvre the ship effectively and securely was a core competence especially for the master, who was responsible for training new crew members.

The master and the first mate allocated the tasks between them, so the master would, inter alia, be responsible for correspondence with the shipping company, agent and business partners. The skipper manoeuvred the ship to and from the dredging vessel and to and from berth. The tasks of the first mate were, inter alia, to handle the organisation of drills on board, route planning, mooring work as well as the ongoing maintenance of the ship in accordance with the ship's maintenance programme.

The usual course of action was that the master and the first mate planned which tasks from the company's maintenance programme were to be carried out. The tasks were typically performed in the period between the ship's loading and unloading operations.

Some of the maintenance and repair tasks were routine tasks that did not involve any significant risk, but some of the tasks could be categorised as critical or special operations on mechanical engineering installations. When the crew faced critical or special operations with which they had some experience, the crew managed the tasks themselves. If the operation was not a familiar one or was particularly difficult, the crew called back to the shipping company to get technical assistance by phone. If the operation could not be solved solely by technical assistance from the shipping company, the company sent a repairman to the ship to carry out the repairs. If it was not possible for the company to send technical assistance, the last solution was for the ship's crew members themselves to arrange repairmen from a company on land.

# **Analysis & conclusion**

The accident on KARIN HØJ in Eemshaven in the Netherlands occurred when the ship was coming in to port in Eemshaven and hit the quay, causing damage to the hydraulic hoses on the starboard propulsion system. The first mate immediately started the repair work on the hydraulic system and was, in connection with this, trapped under a cardan shaft. The accident investigation carried out by DMAIB in conjunction with surveillance images from the port showed that the first mate entered the engine compartment from the starboard side and was lying under the cardan shaft while working to change the damaged hydraulic hoses that controlled the vertical propeller shaft. However, she did not dismantle the hoses that were damaged, but the hydraulic hose that was connected to the lifting cylinder of the cardan shaft. When the hydraulic hose was dismantled, the hydraulic pressure fell in the lifting cylinder, and the cardan shaft was lowered over her.

When the first mate started the replacement of the damaged hydraulic hoses, she entered the engine compartment through the hatch in the starboard side, where there was most room to work. The space conditions around the hydraulic valves in the cardan shaft compartment were limited. The investigations of DMAIB at the scene of the accident showed that there were two access options to the engine compartment to replace the hydraulic hoses. The hatch on the port side of the starboard engine gave access, but the disadvantage of working from this side was that you could not see what you were working on. Access via the hatch on the starboard side of the engine compartment allowed you to get so close to the hydraulic valves and hydraulic hoses that you could see what you were working with. This meant that you had to go under the cardan shaft to change the hydraulic hoses. You could also climb over the cardan shaft and work from there, but this offered a very uncomfortable working position and would not be the natural choice.

It is unclear why she unscrewed the hydraulic hose for the lifting cylinder. There may be two reasons for this.

At the scene of the accident, the investigators found the wrench used for the work by the first mate. The investigation showed that it was difficult to get the wrench onto the fittings of the hydraulic hoses, because the space around the valve battery was limited. It is thus possible that the first mate wanted to loosen the hose that was placed in front of the two hoses to be switched, in order to get better room for changing the hoses. When the hose was dismantled, the pressure immediately disappeared, and the lifting cylinder could not hold the cardan shaft up, causing it to lower, trapping the first mate.

The second possibility is that the first mate mistook the hydraulic hoses and thus unscrewed the hydraulic hose for the lifting cylinder in the belief that it was the hydraulic hose for the actuator.

On board KARIN HØJ, it was normal working practice for the first mate and the master to perform maintenance and minor repairs on machine installations, either alone or following instructions from the technical department of the shipping company. It is the experience of DMAIB that this practice also exists on other ships, where it is common for the first mate to perform tasks other than traditional mate's tasks, such as route planning, mooring work, anchoring, repairs and checks on the ship's rescue equipment and safety equipment. It was therefore a natural task for the first mate on KARIN HØJ to replace two hydraulic hoses, which were visibly damaged and which were essential for the ship's manoeuvrability. Since there were spare hoses, hydraulic oil and tools available, there was nothing to indicate that the task ought to have been carried out later and/or by others.

Since the ship's crew did not possess mechanical engineering skills, they did not recognise that this repair was associated with special risk conditions; conditions relating to the repair of a high-pressure system at a location where there was a possibility of being trapped. The shipping company's procedures for carrying out repairs of this type were characterised as being "important non-routine operations", which should be subject to a risk assessment onboard the ship. No formal risk assessment was carried out before beginning the work, but as the crew did not possess mechanical engineering skills, they could not in reality assess the risk conditions.

On 9 May 2019, the ship's maintenance and repair practices therefore led to the first mate, during work on the replacement of hydraulic hoses, being trapped by the cardan shaft in the ship's starboard engine compartment and perishing.

# Preventive measures

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In this section, the preventive measures prepared by the owner and operator of the ship are stated.

The preventive measures are not prepared on basis of recommendations from the Danish Maritime Accident Investigation Board.

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The Danish Maritime Accident Investigation Board has received the following preventive measures from the shipping company Rederiet Høj:

- *"Lock pins have been mounted in brackets on starboard and port side propeller shaft housing for manual securing of the cardan shaft.*
- *A new procedure for repair of the Schottel system has been implemented in the ship's safety management system. Furthermore, a machine repair procedure has been implemented.*
- *A new lockout-tagout procedure has been implemented. This procedure includes a checklist.*
- *The familiarisation checklist for change of officer has been updated to comprise the procedure for repair of the schottel system.*
- *Warning signs have been posted on access covers to the engine compartments on the port and starboard main engine.*
- *The shipping company Rederiet Høj has updated the ships safety management system with a risk assessment covering repair of machinery."*

# Appendix

## SHIP PARTICULARS

Name:	KARIN HØJ
Type of ship:	Split barge
Flag state:	Denmark (DIS)
Port of registry:	Horsens
IMO number:	8685844
Call sign:	OWHM2
DOC company:	Rederiet Høj A/S
IMO company no. (DOC):	1677271
Year built:	1977
Ship yard/no.:	J.H. van Eijk & Zonen B.V. – Sliedrecht/335
Classification society:	Skuld
Length overall:	55.06 m
Breadth overall:	9.20 m
Gross tonnage:	408
Deadweight:	492 t
Propulsion power:	590 kW
Hull material:	Stål
Hull type:	Enkeltskrog

## VOYAGE PARTICULARS

Port of departure:	Eemshaven, Netherlands
Port of arrival:	Eemshaven, Netherlands
Voyage type:	National voyage
Cargo information:	Ballast
Manning:	2
Pilot on board:	No
Passengers:	None

## WEATHER DATA

Wind – direction and speed:	S – 12 m/s
Visibility:	Good
Light conditions:	Daylight

## MARINE CASUALTY INFORMATION

Type of accident:	Occupational accident
IMO classification:	Very Serious
Date and time:	9. May 2019, 1235 LT
Place of the accident:	Eemshaven, Netherlands
Position:	53°26,56N 006°49,33E
Ship operation, voyage segment:	Dredging, harbour manoeuvre
Human factors:	Yes
Consequences:	One crewmember perished

## SHORE AUTHORITY INVOLVEMENT AND EMERGENCY RESPONSE

Involved parties:	Dutch police, ambulance, rescue team. Crew from a Danish ship, dockers from land.
Resources used:	Ambulance, forklift
Speed of response:	35 minutes from trapping to release.
Actions taken:	The crew member was freed
Results achieved:	The injured person was brought to hospital and declared dead

## PERSONS ON BOARD

Skipper:	55 years, certificate of competency as master (home trade) and a certificate of proficiency in motor operation, 10 years of experience at sea. Had sailed as a master on KARIN HØJ for 7 months.
First mate:	36 years, certificate of competency as mate, 4th class and a certificate of proficiency in motor operation, 13 years of experience at sea. Had sailed as a first mate on KARIN HØJ for 13 months.