DUTCH
SAFETY BOARD

Hatch cover wheel breaks free

Fatal accident on board the Marja

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The Hague, December 2021

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Source cover photo: Dutch Safety Board

The Dutch Safety Board

When accidents or disasters happen, the Dutch Safety Board investigates how it was possible for these to occur, with the aim of learning lessons for the future and, ultimately, improving safety in the Netherlands. The Safety Board is independent and is free to decide which incidents to investigate. In particular, it focuses on situations in which people's personal safety is dependent on third parties, such as the government or companies. In certain cases the Board is under an 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.

INHOUD

1 INTRODUCTION

On 8 February 2018, at around 22.30 hours local time[1], the Dutch general cargo vessel Marja (see figure 1) moored in the port of Mestre (Venice, Italy). An immediate start was made on unloading the containers. During the unloading process, one of the deckhands opened hatch 2B. The deckhand noticed that the wheel on the hatch cover had run between five and seven centimetres clear of the 'rail', at which point he immediately stopped the hatch cover opening sequence. At around 23.15 hours, the chief engineer attempted to hammer the wheel back into position using a sledge hammer. During the process, the wheel suddenly broke free from the axle and fell onto the chest of the chief engineer. The crew immediately started resuscitation, and informed the emergency services. After 20 minutes of resuscitation attempts, on 9 February shortly after midnight, the emergency services on location declared that the chief engineer had died as a result of his injuries.

Figure 1: The Marja. (Source: Etienne Verberckmoes – MarineTraffic)

The accident 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 the Council. This means that the Netherlands, as the flag state, bears the obligation to ensure that an investigation is conducted. This obligation to carry out an investigation is also laid down in the Safety Board Decree.

1 Local time = UTC+1

1.1 The investigation approach

The accident took place in Italy. Following the accident, the Italian police sealed off access to the ship. At the time, the Safety Board choose to ask Italian colleagues from the *Direzione Generale Investigazioni Ferroviarie e Marittime* (DiGiFeMa) to carry out the investigation on board, on behalf of the Safety Board. From the Netherlands, officers of the Maritime Police and an inspector from the Human Environment and Transport Inspectorate (ILT) travelled to Venice, but were refused access to the ship. After several days, they returned to the Netherlands, empty-handed.

In the week following the accident, a fellow investigator from DiGiFeMa went on board the Marja, and was permitted to interview the crew. The DiGiFeMa shared their findings with the Safety Board. However, on board, the fellow Italian investigator was not permitted to visit the accident location, which had been sealed off by the Italian police.

Following the accident, the Italian police seized the wheel and to this day has not granted any other interested parties access to the wheel. One week later, the Dutch Maritime Police travelled to Italy and on this occasion were granted access to the ship. At the request of the Dutch Safety Board, they secured the grease that was still present on the wheel axle.

Investigators from the Dutch Safety Board attempted to collect information in other ways, including a visit to a sister ship with the same hatch cover system, a visit to the manufacturer of the hatch cover system in Germany, and a visit to the Marja, when the vessel had returned to the Netherlands at a later date. The composition of the grease was also compared in the Netherlands with the composition of unused grease of the same type, which was also taken back to the Netherlands.

No technical examination of the wheel or bearings could be carried out due to the seizure by the Italian Police, and following the visit to the manufacturer of the hatch cover system in Germany, initially no further response from the manufacturer was received to questions from the Dutch Safety Board. During the consultation period the new owner of the manufacturer of the hatch cover system eventually did respond to the content of the report.

2 BACKGROUND INFORMATION

2.1 Ship and crew

The Marja was built in 1995 in Hamburg by J.J. Sietas Shipbuilding GmbH & Company KG. Until 2004, the Marja sailed under the German flag, by the name Magda. Scheepvaartonderneming Maaike C.V. took ownership of the Marja on 28 July 2004. The Marja is currently managed by Holwerda Shipmanagement B.V.

At the time of the accident, the crew of the Marja consisted of nine crew members of four nationalities. The captain entered service at Holwerda in 1999. The captain has sailed with the rank of captain since 2008, and since 2012 has been captain of the Marja. At the time of the accident, the captain had been on board for three weeks. The victim, the chief engineer, was of Russian nationality. At the time of his death, he had been on board the Marja for two months. The captain and the victim had worked together for three years.

Position	Nationality
Captain	Dutch
First mate	German
Second mate	Dutch
Chief engineer (victim)	Russian
Trainee engineer	Indonesian
Deckhand cook	Indonesian
Deckhand 1	Indonesian
Deckhand 2	Indonesian
Deckhand 3	Indonesian

Table 1: Positions and nationality of the crew members of the Marja at the time of the accident.

2.2 Hatch cover system

The hatch cover system of the Marja compirses of folding hatch covers. This means that the hatch covers hinge when opening and closing. Each folding pair is operated by means of hydraulic cylinders, located on port and starboard side. During the opening- / closing sequence the trailed covers are supported at their free ends by means of wheels which are running on rails that run in line with the gangways When opened, the hatch covers stand vertically. Figure 2 provides a picture of the folding hatch covers. The advantage of folding hatch covers is that they occupy little space in comparison with hatch covers that have to be stacked, because in this case, the hatch covers stand vertically.

Figure 2: Example of the hatch cover system. (Source: Edvin SKRLJ - MarineTraffic)

2.3 Functioning of the wheel on folding hatch covers

At each hatch cover folding pair, the trailed cover is equipped with wheels located at its free end which run on guide rails located on top of the hatch coamings. The wheels on port side are so-called guide wheels and are of flanged design in order to keep the folding pair via the trailed cover in its specified position during the folding- / unfolding process. The wheel on the port side has a flange which guides the wheel along the rail, during opening and closing, so that the wheel cannot come off the rails. On the starboard side, a freewheel without flanges runs over the rails, in order to maintain free movements of the longitudinal hatch coamings underneath the hatch covers, caused by hull- / hatch coaming deflections depending on loading conditions or structure deformations caused by heat ingress (sun radiation). Figure 3 shows the guide wheel with flanges on the port side, and figure 4 shows the freewheel on the starboard side.

Figure 3: Guide wheel with flanges on the port side. (Source: Dutch Maritime Police)

Figure 4: Freewheel on the starboard side. (Source: Dutch Maritime Police)

The design

The aim of the wheels is to support the movement of the hatch cover folding pair during the folding- (opening-) / unfolding (closing) process.

All installed bearings of both guide- and plain wheels are of spherical-roller type in twin arrangement. The bearings are designed to absorb the radial forces of the hatch cover structures via the wheel bodies into the hatch coaming structure.

Figure 5 as a sample shows a plain wheel located on starboard side. The bearing roller design and -arrangement within the guide wheels on port side is identical. Given the construction of the hatch cover, the axial forces during normal operation are minimal.

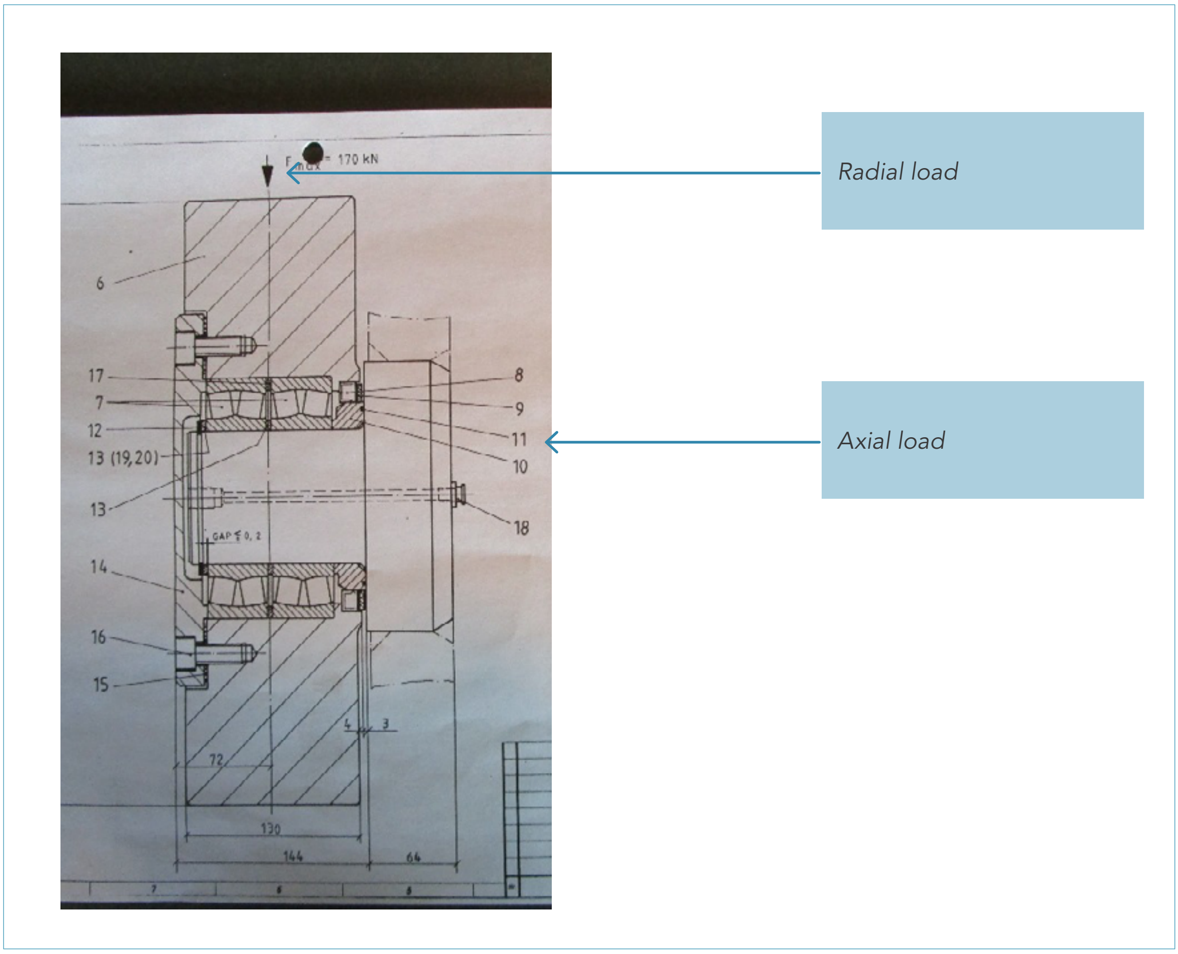

Figure 5: Cross section of the wheel showing radial and axial load

The twin spherical roller bearings are fixed within the wheel bodies by means of a press fit. The wheel bodies (via the press-fitted bearings) are fixed on the wheel axles by means of so-called Seeger circlip, see figure 6. The sole purpose of this circlip is to hold the bearing in place, and not to absorb forces.

Figure 6: Circlip used to retain the bearing

System maintenance

According to a maintenance timetable, the wheels of the hatch cover must be injected with grease every month. The grease is filled in via a grease nipple (pos. 18 of figure 7) into the axle, located at the inner side of the hatch cover side plates, and is led through the boring within the wheel axle to the opposite exit where it is spread all over the space between the axle (pos. 1) and the cover (pos. 14) . From there the grease attains to the bearing rollers. Figure 7 includes a red line that represents the route taken by the grease. The chief engineer is responsible for periodic lubrication. The moment at which the grease is injected is recorded in a grease schedule. The wheel in question was last lubricated with grease on 15 January 2018.

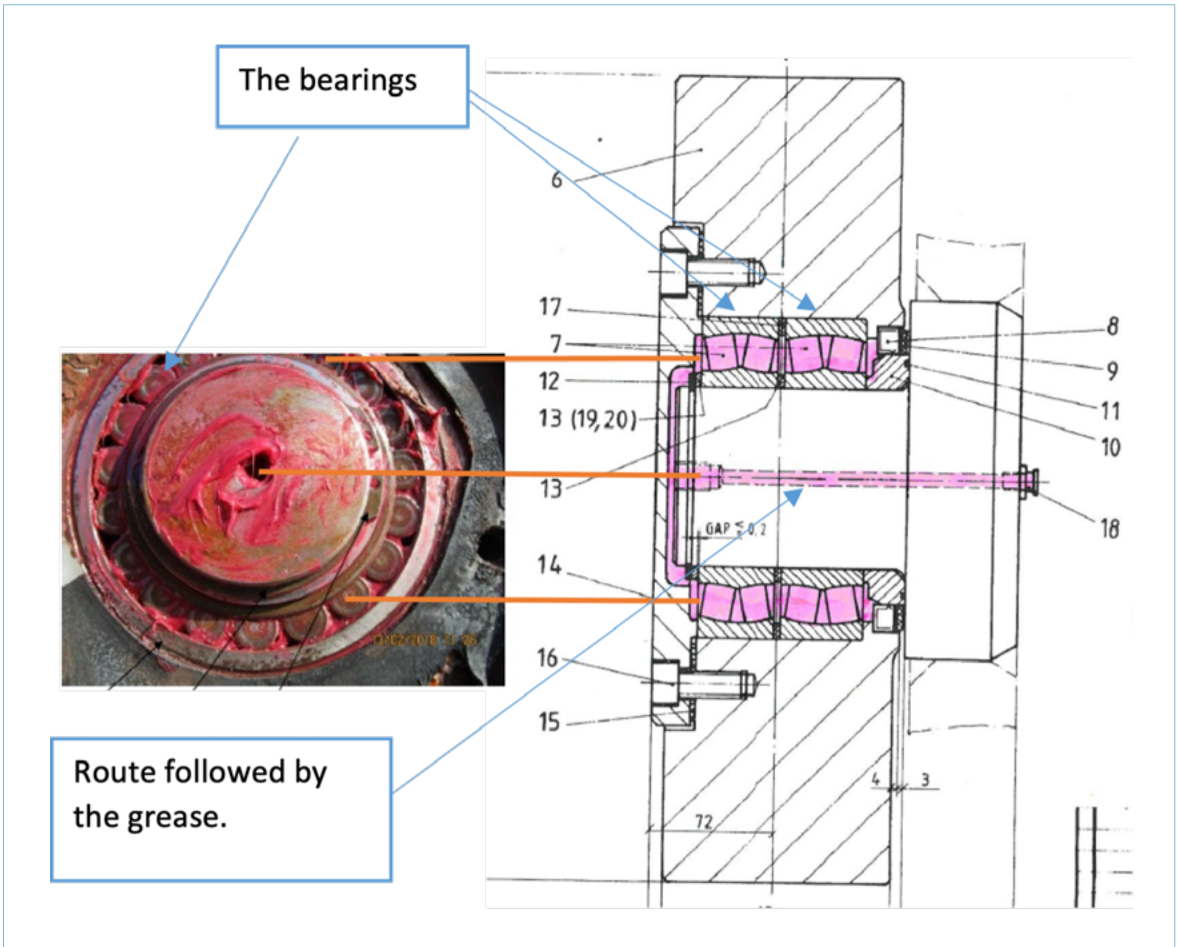

Figure 7: Front of a wheel without cover plate and a graphic reproduction of the wheel. Red: the route taken by the grease, Orange: the corresponding points on the graphic reproduction and the photograph. (Source: Holwerda Shipmanagement B.V.)

The visual inspection of the wheels and the bearings for wear requires considerable preparation and work. The cover plate is difficult to lift off. A tool first has to be installed to be able to remove the plate, see figure 8.

Figure 8: The cover plate onto which an angle bar is welded as a tool for removing the cover plate from the wheel. (Source: Holwerda Shipmanagement B.V.)

The lubrication process, which involves injecting grease until it escapes from the escape hole is the only recorded form of maintenance, no further inspections of the bearings are included in the manufacturer's maintenance schedule.. The maintenance regulations list no further inspections of the running wheels. Not until disruptions or deviations are observed is any form of curative maintenance provided for.

3 COURSE OF EVENTS

On 8 February 2018 at 13.00 hours, the Marja set sail from Trieste (Italy) arriving at the quayside in Mestre (Venice, Italy) at 22.30 hours. Immediately following arrival, work was started unloading four containers on hatch 3A, see figure 9. In the meantime, the first mate started opening hatch cover 3. With the exception of the front hatch, the hatch covers each consist of two parts, A and B. All hatch covers are operated from their own individual local control stands, all located on starboard side at the longitudinal hatch coamings. Each hatch cover / hatch cover pair is operated by a pair of hydraulic cylinders, arranged on P&S outside the hatch coamings. Changing from one control stand to the next takes between three and five minutes. After opening the two parts of hatch cover 3, the first mate moved to the port side gangway, where a deckhand was on watch. The first mate instructed the deckhand to check and open hatch cover 2. The deckhand approached hatch cover 2B and carried out the inspection as instructed. He saw nothing unusual, and, after proceeding to the control stand on starboard, started to open the hatch cover. During the opening of the hatch cover, the deckhand saw that the wheel on the starboard side was not running normally on the rail. He therefore immediately stopped the opening of the hatch covers sequence. He decided to return to the gangway, and in the meantime reported the occurrence to the first mate, via the walkie-talkie. When he arrived at the gangway, the deckhand took over the position from the first mate.

Hatch cover 2B, with behind it hatch cover 3A. Both in opened position.

The first mate approached hatch cover 2B and just like the deckhand, saw that the wheel had run between five and seven centimetres off the axle, and was therefore not in line with the rail. The deckhand called the captain and then the chief engineer. In the meantime, the first mate approached the stevedores on shore, to halt the unloading operation. By this time, the captain and chief engineer had arrived at the wheel, and were in the process of examining the situation, when the first mate arrived back. The chief engineer suggested collecting a sledge hammer to hammer the wheel back into its starting position, on the axle. The captain agreed. While the chief engineer walked away to collect a sledge hammer, the first mate asked the captain whether the unloading operation could be restarted. The captain decided that the unloading operation at hatch 3 could be continued. The first mate duly informed the stevedores. As the first mate started to walk back towards hatch cover 2B, he saw how the chief engineer started to hit the wheel. The captain stood on the other side, with no clear view of the chief engineer; he did however have a clear view of the back of the wheel. After the chief engineer had hit the wheel several times, it unexpectedly came off the axle, and fell towards the gangway. Before the wheel reached the gangway, it hit the chest of the chief engineer. Figure 10 shows the axle to which the wheel was attached, and figure 11 shows the position in the gangway where it ended up.

Figure 10: Wheel axle. (Source: Maritime Police)

Figure 11: Wheel in the gangway. (Source: Maritime Police)

The captain and the first mate ran to the chief engineer, and saw that he had been seriously injured. The captain concentrated on the chief engineer, and instructed the first mate to call an ambulance. In response, the first mate went to shore to ask the stevedores to call an ambulance, because they spoke Italian. The ambulance arrived within just a few minutes, and the first mate accompanied the ambulance medic to the location of the victim, on board. The ambulance medic observed that the victim was no longer responding to stimuli. The doctor who arrived 20 minutes after the start of the resuscitation attempt pronounced the chief engineer dead.

4 ANALYSIS

The analysis of the accident focuses on two crucial moments that led to the wheel breaking free, and eventually to the death of the chief engineer. The first moment is when the wheel starts to come off the axle, and the second moment is the decision by the victim to hit the wheel with a sledge hammer. As described in section 1.1, the Italian police seized the wheel and to this day has refused to cooperate with the investigation. As a result, the Dutch Safety Board is lacking essential information about the cause of the wheel coming off the axle.

4.1 Wheel comes off the axle

The deckhand opened the hatch cover after he had checked the hatch cover rails. Checking the hatch cover and ensuring that there are no objects that can disrupt the opening of the hatch cover are in line with the procedures applicable on board. During the second phase, the deckhand observed that the wheel was not running correctly. He immediately halted the opening procedure, and informed the first mate. The first mate then immediately called the captain and the chief engineer, and halted the unloading operation at hatch cover 3.

The investigation has not revealed previous problems with the wheel of the hatch cover. In order to ascertain how the wheel was able to come off the axle without being able to actually examine the hatch cover wheel or the bearing, following the accident a grease sample was taken from the wheel. This grease was analysed and compared with a sample of unused grease of the same type. Appendix C contains the full results of this analysis. During monthly greasing, as directed by the manufacturer, the grease moves through the bearing. Because the grease is not completely changed every month, the grease will remain in the bearing for a longer period of time and will also have a different composition under normal circumstances than unused grease from the packaging.

The increased levels that were observed of among others Iron, Magnesium and Titanium (see table 2) are indicators in this case that the wheel had not been turning as it should for a longer period of time, and that the roller thrust bearings were no longer functioning correctly.

Substances	New grease from packaging	Sample of grease from the wheel
Iron, mg/kg	55	16000
Magnesium, mg/kg	475	1200
Titanium, mg/kg	2	900
Sodium, mg/kg	1620	2600

Table 2: Increased levels of various substances in the analysed grease.

The malfunctioning of the bearings may eventually have led to the blocking of the bearing race, and the breaking of the circlip (see figure 6). As a result, the wheel was able to run off the axle. Given the passage of the grease through the bearing, it is plausible that the injection of grease made a further negative contribution.

System maintenance
The lubrication process, which involves injecting grease until it escapes from the escape hole is the only recorded form of maintenance. The maintenance regulations list no further inspections of the running wheels. In addition, the visual inspection of the wheels and the bearings for wear requires considerable preparation and work.

However, there are ways of periodically checking the correct functioning of the bearings, without having to remove the cover plate from the wheel. In the closed position of the hatch cover folding pairs, the hatch covers rest on and are locked to the hatch coamings. All wheels are located in pockets / recesses where they are hanging completely free and unloaded. This a must as the wheels are not designed to bear any further loads resulting from the container loads on top of the hatch covers. In this position the wheels can be easily moved (turned) resp. inspected for free movement and for the straight seat on the axle.

4.2 Decision to hammer the wheel back into place, with a sledge hammer

After the first mate had called them, the captain and chief engineer arrived on the scene to inspect the situation. Within the shipping company or on board, there is no procedure in place that describes how the crew needs to handle in situations that are unforeseen (and rare), since it is not possible to create procedures for all possible scenarios that occur on board a ship. The crew's self-reliance and skill are relied upon to solve these types of problems, which generally leads to good and quick results. Given his technical experience in the engine room, the chief engineer is seen as the most obvious person to solve technical problems on board a ship. However, a chief mechanical engineer does not necessarily has to have knowledge of the hatch system and must, on the basis of his other technical knowledge and experience, evaluate how this problem can best be solved. The captain and chief mate had never experienced a similar problem with the hatch before, it is unknown whether this also applied to the chief engineer.

Both the captain as the chief engineer were of the opinion that the problem needed to be solved as quickly as possible. Continuing with the unloading process, and the fact that the unloading process was restricted because the hatch cover could not be opened, received high priority in identifying a solution to putting the wheel back in place. A possible consequence of temporarily stopping unloading could be that the shore crew (which has its own deadlines) continues to handle another ship, causing the operation to be delayed.

As a result, the crew was confronted with a 'goal conflict'[2] between making progress with the resolution and performing a more extensive analysis of the problem, a so-called Efficiency Thoroughness Trade Off (ETTO, see blue box). In the case of the hatch cover wheel, the decision was taken to return the wheel to its starting position as quickly as possible, the expectation being that it should be possible to return the wheel to its correct position, using a sledge hammer.

The Efficiency Thoroughness Trade Off

The ETTO principle refers to the practice in which people and organisations must weigh up spending time and effort to prepare their tasks and spending time and effort in performing these tasks. The challenge is to find a balance between completeness and efficiency. It is impossible to maximise both completeness and efficiency simultaneously. One aspect will be detrimental to the other aspect. (E. Hollnagel, The ETTO Principle: Efficiency Thoroughness Trade-Off (2009).

Implicitly or otherwise, the various parties agreed to the use of the sledge hammer. No explicit reference was made to potential risks or consequences. At the start of any task that has never previously been carried out, there are a number of instruments available to ensure safe working. One vital aspect of safe working is to remain critical and to keep asking each other whether safety is guaranteed. The captain had worked with the chief engineer for three years, and was always satisfied with the chief engineer's work; for that reason, the captain experienced no doubts whatsoever about the method proposed by the chief engineer for returning the wheel to its position on the axle.

2 Systems Thinking for Safety: Ten Principles A White Paper, page 20 https://www.skybrary.aero/bookshelf/books/2882.pdf)

Last Minute Risk Analysis

An LMRA is an instrument that can be used for a final risk assessment for (new) tasks. As part of this analysis, the risks that can arise during work are estimated, in order to obtain a clear picture of any risks present and how they can be mitigated. The LMRA is undertaken shortly before the start of work, and is most effective when several people contribute ideas regarding the risks. As it may be necessary to pause production for a short period of time to perform an LMRA, it is essential that a company / shipping company understands the crew's choice to deploy an LMRA in order to make this workable in practice.

Figure 12: Similar wheel on a sister ship of the Marja.

Figure 12 is a photo taken on a sister ship of the Marja. The photo shows that half the weight of the hatch is transferred to the wheel The wheel has an intrinsic weight of approx. 300 kg. Given the height at which the wheel is fitted, due to its mass, it contains considerable stored (potential) energy which is released if the wheel breaks free and falls. It is essential to recognize that the mass of the wheel represents considerable potential energy.

It is vital that crew members on board a ship trust one another. However, it is at least as important that irrespective of their position, crew members encourage one another to first observe a situation from a professional distance, before taking action. In a situation when everyone on board fully trusts a person's ability, and that same person is also fully confident in his own ability, a situation can arise which is poorly judged.

When day-to-day operations have to be shut down due to a technical problem, in addition to the initial question 'How can this problem be solved as quickly as possible?', the question 'How can this problem be solved safely?' should also be asked, simultaneously. The dilemma here is that a decline in production is immediately noticeable and recognizable, but that the possible consequences for safety can be unimaginable, because the chance of an incident is very small. Holding an LMRA creates a moment of calm and consideration at a time when an operational problem needs to be solved. The LMRA can also ensure that consideration is given to how the problem can be solved safely and quickly. The ship manager can assist the crew by introducing this tried-and-tested method from industry, as a standard practice, on board.

5 CONCLUSIONS

Two crucial moments led to the breaking free of the hatch cover wheel and subsequently the death of the chief engineer on the Marja. The first moment was when the wheel had partially run free from the axle, and the second moment was the decision to hit the wheel with a sledge hammer. The chief engineer was killed when while hitting the wheel, it unexpectedly came free from the axle, and landed on his chest.

Coming free of the wheel

The wheel was able to run free from the axle because the circlip that was used to secure the wheel onto the axle was no longer working. The Safety Board was unable to determine the precise cause, with absolute certainty. With the limited information available, the Safety Board was able to generate a picture of how the wheel was able to come off the axle. The analysis of the grease left behind on the axle, and which was subsequently secured, contained indications that the bearings were no longer functioning correctly, and that the wheel at some point had become stuck. As a result of the build-up of pressure, the circlip securing the wheel must have broken.

Functioning of the bearings

The fact that the bearings were no longer functioning correctly contributed to the occurrence of the accident. The lubrication process, which involves injecting grease until it escapes from the escape hole is the only recorded form of maintenance. The maintenance regulations list no further inspections of the running wheels. In addition, the visual inspection of the wheels and the bearings for wear requires considerable preparation and work.

However, there are ways of periodically checking the correct functioning of the bearings, without having to remove the cover plate from the wheel. The weight of the hatch cover can for example be released from the wheel, so that the rotation of the wheel and the functioning of the bearings can be checked.

Risk estimation

Implicitly or otherwise, the various parties agreed to the use of the sledge hammer to hammer the wheel of the hatch cover back into its starting position. No explicit reference was made to potential risks or consequences of this action.

There was an operational problem that had to be solved in order to be able to continue with the day-to-day activities. The persons involved wanted to solve the problem as quickly as possible.

In situations of this kind, introducing an instrument for risk analysis encourages the persons involved to examine the situation from a professional distance. The aim of the analysis is to ensure that the risks and consequences are analysed and consideration is given as to how these risks and consequences can be mitigated or removed, before taking action. The ship manager can assist the crew by introducing a standard working method that can be employed whenever an operational problem arises that needs to be solved. As well as coming up with a solution to the problem, the question must also always be asked whether the proposed solution is safe.

Vessel Data Marja

Vessel data Marja

Call letters:	PHBB
IMO number:	9113721
Flag State:	The Netherlands
Home port:	Heerenveen
Type of ship:	Container ship
Classification society:	DNV GL
Year of construction:	1995
Shipyard:	J.J. Sietas Shipbuilding GmbH & Company KG
Length overall (Loa):	100.58 m
Length between perpendiculars (LPP):	96 m
Breadth:	18.2 m
Actual draught:	6.55 m
Gross Tonnage:	3999
Engines:	Deutz MWM
Propulsion:	Adjustable propeller
Maximum propulsion capacity:	3878 kW
Maximum speed:	15.0 knots
Vessel certificates:	All valid

APPENDIX B

Reactions 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:
- Holwerda Shipmanagement B.V.
- EnPro GmbH (former MACOR)

The responses received were dealt with in the following manner:
- Rectifications to 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.
- 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 reactions and the explanatory notes appear in a table that can be accessed via the website of the Dutch Safety Board (www.onderzoeksraad.nl).

APPENDIX C

Results of grease analysis

SGS

DE ONDERZOEKSRAAD VOOR
VEILIGHEID
Postbus 95404
2509 CK Den Haag

ANALYTICAL REPORT SR-1853633.01.A01 P.1/2

grade	GREASE
sample 001	Sample received from client Sample packed in plastic back quantity approx. 0.1 G Sample marked as No label 1
sample 002	Sample received from client Sample packed in plastic back quantity approx. 0.1 G Sample marked as No label 2
date received	19.03.2018

Elements with ICP (SGS SPI 110)	001	002
- Aluminium as Al, mg/kg	200	400
- Barium as Ba, mg/kg	3	195
- Calcium as Ca, mg/kg	1000	2675
- Chromium as Cr, mg/kg	5	40
- Copper as Cu, mg/kg	<1	20
- Iron as Fe, mg/kg	55	16000
- Magnesium as Mg, mg/kg	475	1200
- Lithium as Li, mg/kg	8850	8220
- Manganese as Mn, mg/kg	1	190
- Sodium as Na, mg/kg	1620	2600
- Nickel as Ni, mg/kg	1	15
- Phosphorous as P, mg/kg	2875	2100
- Strontium as Sr, mg/kg	<1	6

SGS

ANALYTICAL REPORT SR-1853633.01.A01

	001	002
- Titanium as Ti, mg/kg	2	900
- Zinc as Zn, mg/kg	5125	5470
- Silicon as Si, mg/kg	600	900
- Sulphur as S, mg/kg	10400	8200

Samples will be retained for 3 months unless instructed otherwise.
End of analytical results

Spijkenisse, the 13th April 2018
SGS Nederland B.V. - Oil, Gas and Chemicals

[redacted]

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