Danish Maritime Accident Investigation Board

MARINE ACCIDENT REPORT
April 2013

ANNA MÆRSK

Fatal accident to seafarer on 27 March 2012

The Danish Maritime Accident Investigation Board
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This marine accident report is issued on 19 April 2013

Case number: 2012003810

Front page: www.shipspotting.com / Fred W Meijer

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

The Danish Maritime Accident Investigation Board

The Danish Maritime Accident Investigation Board is an independent unit under the Ministry of Business and Growth that carries out investigations with a view to preventing accidents and promoting initiatives that will enhance safety at sea.

The Danish Maritime Accident Investigation Board is an impartial unit which is, organizationally and legally, independent of other parties

Purpose

The purpose of the Danish Maritime Accident Investigation Board is to investigate maritime accidents and to make recommendations for improving safety, and it forms part of a collaboration with similar investigation bodies in other countries. The Danish Maritime Accident Investigation Board investigates maritime accidents and occupational accidents on board Danish merchant and fishing vessels as well as accidents on foreign ships in Danish territorial waters.

The investigations of the Danish Maritime Accident Investigation Board procure information about the actual circumstances of accidents and clarify the sequence of events and reasons leading to these accidents.

The investigations are carried out separate from the criminal investigation. The criminal and/or liability aspects of accidents are not considered.

Marine accident reports and summary reports

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

Contents

1. SUMMARY

On 27 March 2012, a drill with the vessel's rescue boat was planned while the vessel was alongside in Kobe, Japan. When the second of the two crewmembers entered the boat at the embarkation level, the jaw end of a swivel connected to the rescue boat's hook failed due to a damaged split pin, and the boat fell approximately 18 meters to the sea with the two crewmembers on board.

One able seaman (AB) was killed instantly when the boat hit the water. The other crewmember was severely injured but with the prospects of a full recovery.

This report contain a safety recommendation to the Danish Maritime Authority

The ship manager has taken preventive measures.

2. FACTUAL INFORMATION

2.1 Photo of the ship

Figure 1: ANNA MÆRSK
Source: www.shipspotting.com/Dave Van Spronsen

2.2 Ship particulars

Name of vessel:	ANNA MÆRSK
Type of vessel:	Container vessel
Nationality/flag:	Denmark (DIS)
Port of registry:	Aabenraa
IMO number:	9260421
Call sign:	OXBA2
DOC company:	A.P. Moller-Maersk A/S
IMO company no. (DOC):	0309317
Year built:	2003
Shipyard/yard number:	Odense Staalskibsvaerft A/S/Yard number 186
Classification society:	American Bureau of Shipping
Length overall:	352.60 m
Breadth overall:	42.80 m
Gross tonnage:	93,496
Deadweight:	109,000 t
Draught max.:	15.00 m
Engine rating:	63,036 kW
Service speed:	25.0 knots
Hull material:	Steel

2.3 Voyage particulars

Last port of call:	Singapore
Port of call:	Kobe, Japan
Type of voyage:	Merchant shipping, international
Cargo information:	General cargo in containers
Manning:	26
Pilot on board:	No
Number of passengers:	0

2.4 Marine casualty or incident information

Type of marine casualty/incident:	Fatal accident to seafarer
IMO classification:	Very serious casualty
Date, time:	27 March 2012, approximately 1115 LT
Location:	Alongside, Kobe Rokko Terminal PC-5, Japan
Position:	34º 39'4 N/135º 14'1 E
Ship's operation, voyage segment:	Alongside
Place on board:	Boat deck
Consequences:	One crewmember killed, one crewmember seriously injured. Rescue boat damaged.

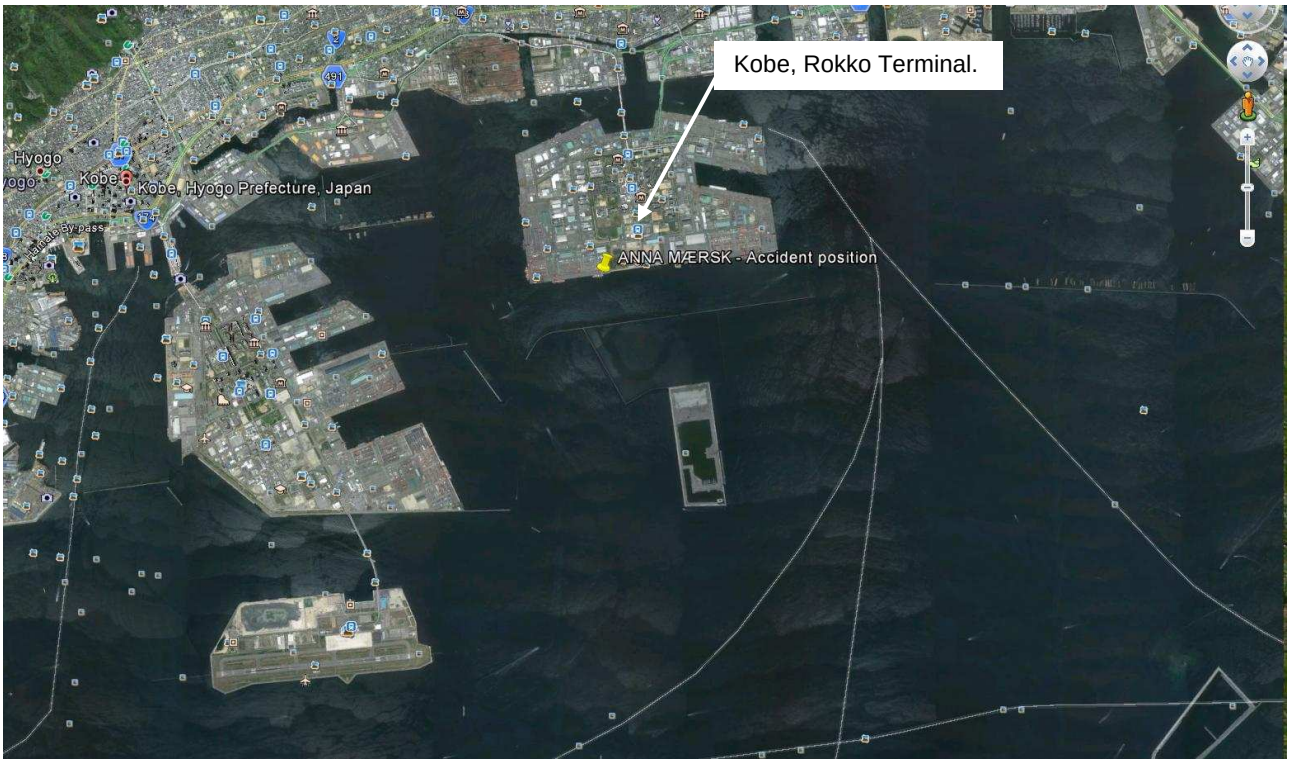

Figure 2: Scene of the accident.
Source: Google Earth

2.5 Shore authority involvement and emergency response

Involved parties:	Japanese medical services, Japanese police, Japan Transport Safety Board
Resources used:	Ambulance, paramedics, policemen
Speed of response:	Within 10 minutes
Actions taken:	Deceased and injured person brought ashore to local hospital. Injured person undergoing surgery and later transported to home country.

2.6 Involved crewmembers

Master:	68 years of age. Certificate as master mariner without limitations. In company since 1970. Master since 1990. Serving on vessel type for 12 years. Serving on ANNA MAERSK for 2 years.
Chief officer (injured):	34 years of age. Certificate as master mariner without limitations. Working for the company since 2002. Promoted to chief officer in August 2009 on board ANNA MÆRSK and has been on the same vessel since.
2nd officer:	37 years of age. Certificate as junior deck officer. Working for the company since 2004 as able seaman. As deck officer since 2009. On vessel since 20 March 2012.
Chief engineer (signing on):	39 years of age. Certificate as chief engineer without limitations. Working for the company since 1998. Chief engineer since 2005. Chief engineer on vessel since 2008.
Chief engineer (signing off):	30 years of age. Certificate equal to chief engineer without limitations. Working for the company since 2000. Chief engineer since 2011. Chief engineer on vessel since 2011.
Able seaman (deceased):	36 years of age. Working for the company for approximately 6 years, serving on container vessels. Less than 1 year of service on board this class of vessel.

3. NARRATIVE

3.1 Background

According to the company's Safety Management System (SMS) procedures, the rescue boat was to be launched and water borne at least every month. The launch of the rescue boat was due during ANNA MÆRSK's call at Singapore, but due to the restricted time available in Singapore, it was decided to postpone the launching until the vessel's arrival in Kobe.

Prior to arriving in Kobe it was therefore decided to launch the life boat as well as the rescue boat during the port stay in Kobe.

3.2 Sequence of events

ANNA MÆRSK arrived in Kobe on 27 March 2012 at 0830 local time. The rescue boat was due to be launched, and it was planned to launch the port side life boat and the rescue boat during the port stay in Kobe. The launching and the sailing with the life boat went without incidents, and the boat was brought back on board and secured. Following the life boat drill, the crew had a toolbox meeting with the crewmembers regarding the rescue boat drill . During this meeting the launching procedure was discussed, and it was decided that the later deceased AB should crew the rescue boat as he had signed on ANNA MÆRSK one week prior to the accident and therefore needed routine in operating the rescue boat. According to the vessel's "Man-Overboard" muster list, the rescue boat should be crewed by the chief officer, the first engineer and one AB. During the exercise only the chief officer and the AB would be crewing the rescue boat.

Prior to the drill the chief officer had requested an engineer to operate the rescue boat crane during the drill. Following the toolbox meeting, the rescue boat hook was checked to ensure that it was properly locked and connected to the hoisting arrangement of the rescue boat. The engineer went to the rescue boat crane, and, as per company procedure, tested the crane. As part of the pre-exercise test, the rescue boat was first lifted from it's craddle by lifting the crane arm and slewed out over the ship's side. Then the boat was returned to the craddle in order to test the limit switch. The limit switch was found in good working order, and the rescue boat hook was subsequently cleared from the limit switch by manually grapping the hook and pulling on the wire.

As a last test prior to the drill, the boat was again slewed over the side and then lowered to the boat deck and hoisted back up in order to check if it was possible to hoist the boat with the winch. The winch worked as it should and no defects were noticed during these tests. Finally the boat was again lowered to the boat deck from where the embarkation would take place. The boat was prepared for embarkation and the crane was slewed in order for the boat to rest against the ship's side thereby easing the embarkation.

The later deceased AB embarked the rescue boat first. He moved to a standing position in the port side just aft of the centreline handrail (see figure 3 below). At this time nothing out of the ordinary was noticed by any of the crewmembers participating in the exercise. When the AB had positioned himself in the boat, the chief officer embarked. The chief officer took approximately two steps forward and passed forward of the centreline handrail to the port side in the boat when suddenly without warning the boat fell approximately 18 metres to the water.

After the boat had hit the water, the chief officer remained conscious but initially confused. He found himself laying in the port side forward in the boat. He quickly became aware of several fractures to his arms and legs. He observed the AB lying further aft in the port side, but the AB showed no signs of life. Due to his own injuries and the fear of any spinal damages, it was not possible to examine further or assist the AB.

The remaining crew on board ANNA MÆRSK reacted immediately to the accident. The port side gangway was rigged and from the lower recess of the gangway a crewmember jumped into the water, entered the rescue boat and secured the hook from the stores part of the combined crane in the lifting ring of the rescue boat. The boat with the three persons on board was then hoisted to the boat deck of ANNA MÆRSK. It is estimated that it took 15-20 minutes from the boat fell to the water until the boat was landed on the boat deck of ANNA MÆRSK.

The crew immediately started first aid, and within 5 to 10 minutes from the rescue boat being landed on the boat deck local paramedics arrived at the scene and took over the treatment. At no time did the AB show any signs os life. It was not possible to resuscitate him, and he was declared dead while still on board ANNA MÆRSK. The chief officer was brought to a local hospital and received treatment for several fractures in his arms and legs. At the hospital it was established that there were no spinal injuries, no internal injuries and no injuries to the head or neck, and a full recovery is expected.

3.3 The rescue boat arrangement

The rescue boat on board ANNA MÆRSK consisted of a RB 430 rescue boat manufactured by ”Ernst Hatecke” as seen in figure 3 below. The complete rescue boat arrangement as seen in figure 4 below was a combined stores crane and rescue boat crane. The two functions, stores crane and rescue boat crane, were separated and used different hook systems.

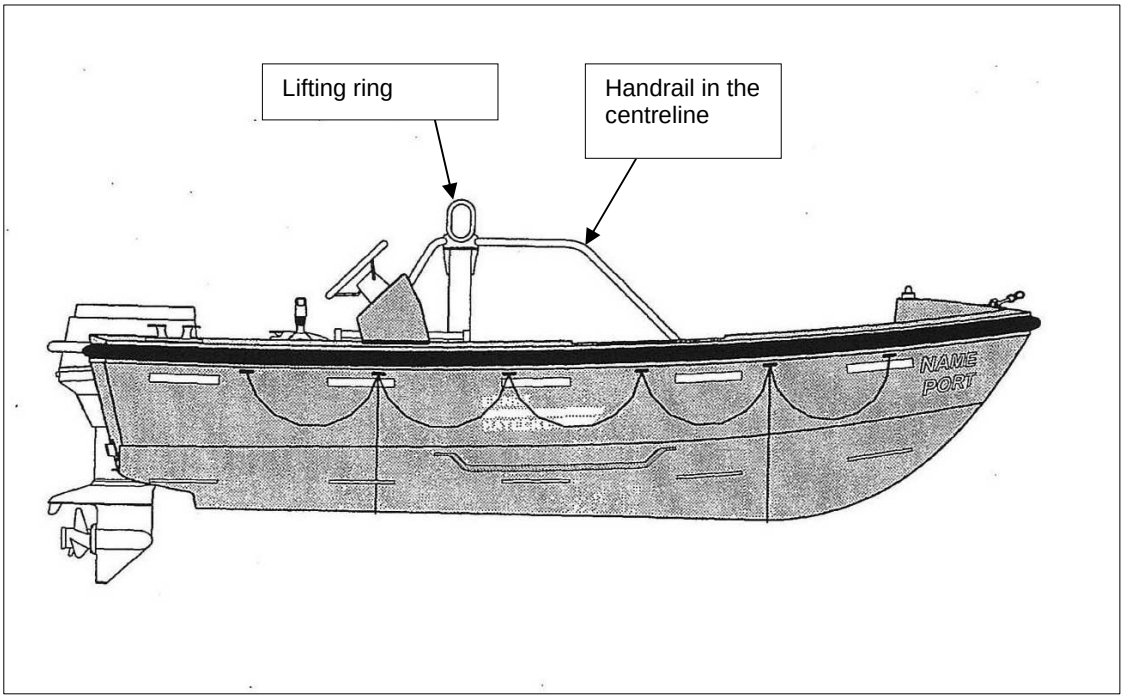

Figure 3: The rescue boat
Source: A.P. Moeller-Maersk

From the wire fall the boat was suspended in a hook arrangement consisting of an off-load hook and a swivel. The swivel was composed of a fork end shackle and a green pin shackle as seen in figure 5 below. The actual hook arrangement can be seen in figure 6 below.

Compared to the intended direction of installing the hook arrangement, the actual arrangement was installed upside down. It has not been possible to establish when the arrangement was first installed upside down. All involved personnel who were interviewed by the investigation board only remember having seen the arrangement installed as on the day of the accident.

Figure 4: The rescue boat/stores crane arrangement with the boat in the stored position
Source: DMAIB

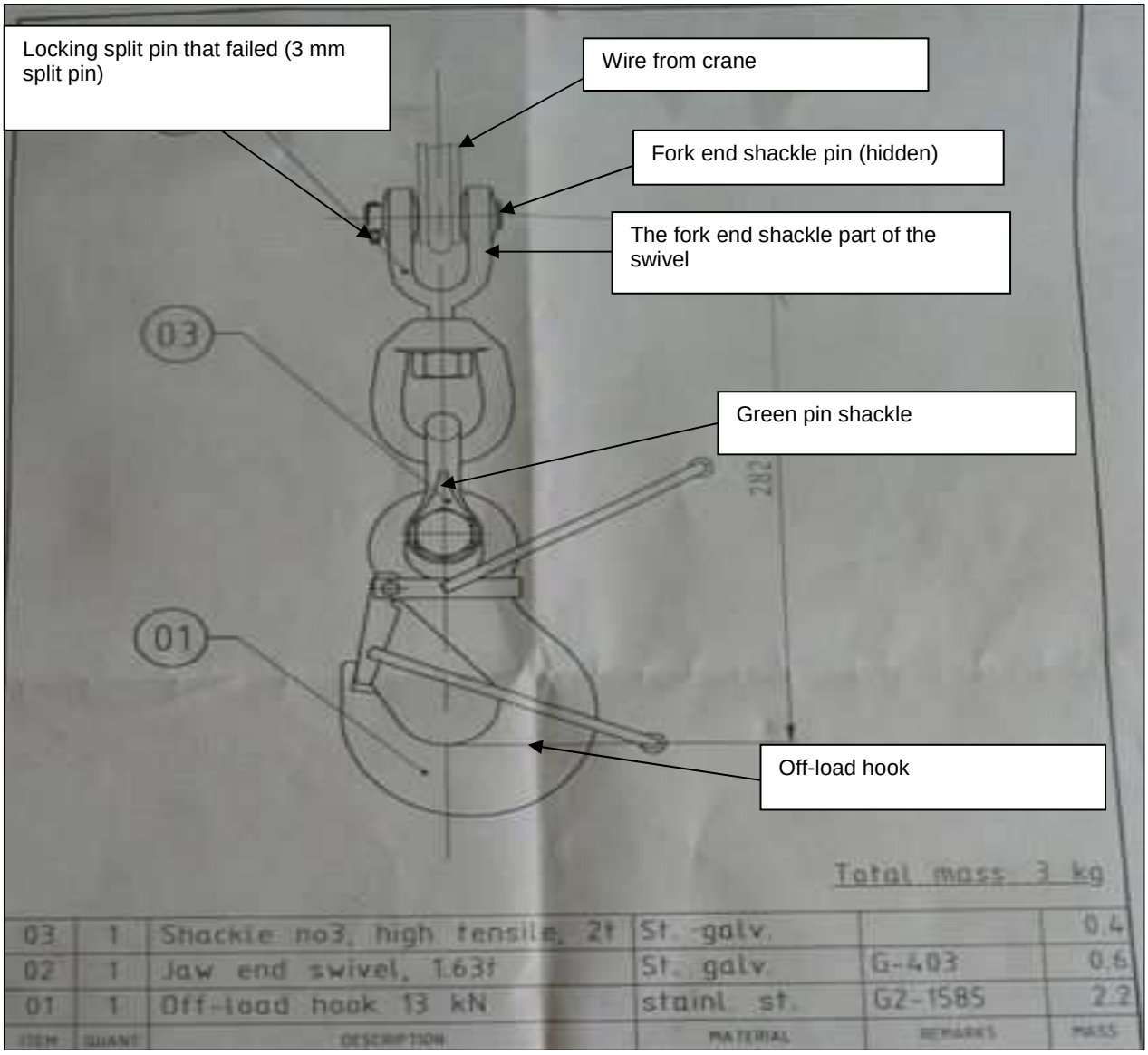

Figure 5: Picture of manufacturer's drawing of the hook arrangement
Source: Davit International/A.P. Moller-Maersk

In the green pin shackle end of the arrangement, the pin was secured with a nut and a split pin. In contrast, in the fork end shackle the pin was secured only by one 3 mm split pin made of mild steel. As this split pin broke away, the pin was able to work itself out of the swivel fork. When this happened, all the weight from the rescue boat, equipment and crew was in an instant transferred to the pin and one side of the fork. This created a bending moment that caused the opposite leg of the fork to bend as seen in figure 6 below. The opening caused by the bending leg in the fork enabled the off-load hook to pass between the pin and the other side of the fork.

Figure 7 below shows the fork end shackle pin with the remaining parts of the split pin. Also seen is the scrape mark from the fork end shackle pin losing its grip in the fork.

According to a report from FORCE TECHNOLOGY published following their metallurgical analysis of the hook system following the accident, the shackle, swivel and off-load hook showed signs of being exposed to the environment, but did not appear corroded. This report and the analysis was made at the request of the ship owner following the accident.

Figure 6: The hook arrangement following the accident
Source: DMAIB

Figure 7: The fork end shackle pin with marks after split pin and scrape marks from losing grip and contact with the fork end
Source: DMAIB

3.4 Maintenance/operation of the rescue boat, crane and suspension

3.4.1 Maintenance

In line with all other A.P. Moller-Maersk line vessels, programmed maintenance on board ANNA MÆRSK was governed by the RDRM system (Repair, design, requisition and maintenance system), which generally has proved to be an effective system to govern the programmed maintenance work on board Maersk Line vessels.

RDRM is a computer-based system which stipulates at which intervals checks and maintenance should be conducted and instructs how the checks/maintenance should be performed. Instructions in the RDRM system are made by the operator and are not specified for each individual vessel. The instructions include quotations from the relevant part of the SOLAS Convention. As a consequence the instructions are generic and not specific for each vessel, wherefore on board the individual vessel the crew must relate to the instructions relevant for their vessel. When

check/maintenance as per RDRM has been completed, the relevant RDRM maintenance activity is updated electronically in the system.

The RDRM system describes different checks and programmed maintenance to be performed at fixed intervals of 1 month, 3 months, 1 year and 5 years, respectively. Apart from load tests of cranes, all checks and maintenance work relevant for the rescue boat, the rescue boat crane and connected systems can be performed by the vessel's own crew in Danish flagged vessels as approved by the Danish Maritime Authority, wherefore external assistance by, for example, manufacturer's specialists is not considered necessary for these tasks.

3.4.2 Weekly inspections

In addition to the maintenance/checks governed by the RDRM system, weekly checks of live-saving appliances (LSA) are performed as per the SOLAS Convention. As per SOLAS convention these checks are primarily visual checks, and they are documented in the paper file, the SOLAS Maintenance Manual. The SOLAS Maintenance Manual is an uncontrolled document, and when received on board the individual vessel the base manual for this system is generic. The crew on the vessel then adapt the content of the file to the equipment on board their vessel. Only very general instructions regarding how to perform maintenance or which items to check is given in the base file. How checks are performed and which items are checked can therefore differ from one vessel to another and individually from the different crewmembers performing the checks depending on their previous experience.

On board ANNA MÆRSK weekly checks of on-board life-saving appliances were conducted by a deck officer except for engine items (life boat engines, etc.) which were conducted by an engineer.

Neither the generic instructions given in the RDRM system nor the vessel-specific instructions in the SOLAS Maintenance Manual specifically described a check of the split pin in the hook arrangement. However, SOLAS reg. III/20/6.2 (weekly inspections) notes that: *"… all survival craft, rescue boats and launching appliances shall be visually inspected to ensure that they are ready for use. The inspection shall include, but is not limited to, the condition of the hooks, their attachment to the lifeboat and the on-load release gear being properly and completely reset …".* indicating that the weekly visual check is expected to screen for such equipment breakdowns.

When a new deck officer signed on the vessel, there was no formal way of introducing the new officer to the task of performing the weekly checks of live-saving appliances. The instructions and checklists given in the SOLAS Maintenance Manual were considered as sufficient instruction in the task.

3.4.3 Status of maintenance and inspections

Both in the SOLAS file and in RDRM system, all jobs were up-to-date as per below:

- **24 March 2012 –** Last weekly visual inspection registered in the SOLAS file. All was noted as being in good order.

- **22 March 2012 –** Last monthly check of the "STORES/RESCUE BOAT CRANE PS" registered in the RDRM system.

- **6 June 2011 –** Last yearly inspection and maintenance performed and registered in the RDRM system.

- **25 March 2008 –** Last 5 yearly inspection and maintenance registered in the RDRM system. Work performed in connection with the vessel being dry docked.

Also registered in the vessel's RDRM system:

- **18 March 2008** – Changing of split pins on the bolts holding the shackles and off-load hook on the rescue boat part of the crane. In this registration no remark of the shackle/swivel arrangement being installed upside down was made.

- **27 March 2008** – Load test and yearly service of rescue boat crane and stores crane performed by manufacturer's authorized shore company/service station during vessel's dry docking.

- **26 January 2011 – Change of the rescue boat hoist wire.** No remark of the shackle/swivel arrangement being installed upside down was made. When changing the wire, only the green pin shackle part of the shackle/swivel arrangement was opened as this was the part connected to the rescue boat hoist wire being replaced. The pin in the fork end shackle was not opened and remained connected to the off-load hook. Consequently, when reconnecting the system, only the split pin in the green pin shackle end of the arrangement was replaced.

3.4.4 Work distribution between engine and deck departments

In relation to the rescue boat crane and stores crane arrangement in general, checks and work items connected to the hydraulic and mechanical parts of the arrangement were done by the engine department. Lubrication and checks/maintenance of the wires in the system and the rescue boat and its equipment were conducted by the deck department.

These tasks were distributed between the chief engineer, chief officer, 2nd engineer, 3rd engineer, 3rd officer and the able seamen.

As per Danish legislation, no formal qualifications were required for maintaining or operating the cranes. According to this legislation, the master, chief engineer, chief officer and 2nd engineer were considered 'competent parties category C'. These competent parties either performed the necessary work themselves or delegated work to available crewmembers. Maintenance of the lifting appliances was considered part of the normal maintenance work.

Which of the crewmembers should conduct any given maintenance activity was decided after considering who was available and who of the available crewmembers was the one most qualified to perform the job at hand.

As a consequence, the normal and programmed maintenance of the crane equipment was performed by the ship's crew, and the educational background as either an engineer or a deck officer was considered sufficient background to understand the arrangements and to seek the necessary information prior to maintenance work.

3.4.5 Operation of the crane

There were no formal qualification requirements for crewmembers operating the vessel's cranes. On muster lists (rescue boat, abandon ship, etc.), the assignment of crewmembers for tasks involving operation of the crane was made on the basis of the crewmembers' position on board and not of their qualifications regarding crane operation. Training in crane operation was conducted as 'on the job'-training and 'learning by doing'.

On the 'man over board' muster list, one of the vessel's third engineers was assigned to operate the crane during the launching of the rescue boat.

When the chief officer called the engine department to request an engineer to assist during the drill, one of the third engineers went to assist with the drill. This engineer was not chosen because

he was the crewmember assigned to the job on the muster list, but because he had crane operation experience from previous occasions.

3.4.6 Planning and organisation of drills

Planning of fire drills, life boat drills and rescue boat drills was done by the chief officer. The conduction of drills was registered electronically in the vessel's SMS system. On board ANNA MÆRSK, the chief officer also registered drills in a paper file kept on the bridge. In this paper file, remarks and written debriefings following drills could be entered. Registration in this paper file was not a company requirement.

3.5 Regulation

The IMO document MSC/Circ. 1206 states that life boats and their launching appliances should be inspected annually by an authorised person approved by the manufacturer. Currently this is not mandatory, as it is not yet proven that a global network of such authorised persons is available.

When the current MSC/Circ. 1206 was prepared, rescue boats and its launching appliances were excluded from this recommended annual inspection conducted by an authorised person. However, a proposal that this requirement should be made mandatory also for rescue boats and its launching appliances is being considered.

The Danish Maritime Authority (DMA) considers all on-board cranes, apart from cranes having functions in connection with life-saving appliances (LSA cranes), governed by a technical regulation[1] issued by the DMA. According to the DMA, this ensures that such non-LSA cranes on board ships are subject to inspections and maintenance to the level described in the technical regulation.

LSA cranes are governed by the EU Directive issued by the EU Commission[2] which implements the International Maritime Organization's (IMO) SOLAS/LSA standards in European legislation. This EU Directive is implemented in Danish legislation by a technical regulation[3], which stipulates what equipment must be on board vessels. The technical and detailed requirements to this equipment are found in the order on equipment in ships[4], which is also issued by the DMA.

The statement described by the IMO legal instrument[5] to be issued by the manufacturer when annual and 5-yearly thorough inspections have been performed on LSA equipment by manufacturer's qualified personnel is not mandatory on board Danish flagged vessels.

Because the crane was a combined crane used for both LSA purposes and non-LSA purposes, the crane should fulfil both the technical regulation and the EU directive mentioned.

3.6 Danish Maritime Authority's guidance on safety during drills

Acknowledging that an unacceptable number of serious accidents have occurred during abandon ship drills, rescue boat drills and fire drills, the Danish Maritime Authority issued guidance no. 5, "Guidance on safety during abandon ship drills and fire drills on board ships" on 22 November 2002.

Among the advice given is the possibility of completely leaving out elements of drills if these elements are considered to involve unnecessary risk.

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[1] Technical Regulation no. 12 of 12 October 2000 on lifting appliances and cargo handling gear on ships.
[2] EU Commission Directive 2009/26/EC on Marine Equipment.
[3] DMA Technical Regulation, Chapter III
[4] Bekendtgørelse om udstyr i skibe, No 983 of 9 October 2012
[5] As per MSC/Circ. 1206, annex 1, chapter 15.

3.7 Approval and certification process

The Danish Maritime Authority has delegated the approval of the rescue boat crane and the stores crane arrangements to the classification societies. When the arrangement was approved by the classification society, the certification process was split up into the following steps:

An approval of the design drawings prior to manufacturing
An approval by the classification society based on the design drawings of the actual arrangement. The classification society primarily considers the design strength of the system and confirms that all individual parts of the arrangements are approved and certified. Whether or not the design of the system and its individual parts are appropriate is not considered.

A survey of the arrangement at the factory when manufactured
A survey of the actual arrangement at the factory carried out by a surveyor from the classification society. The survey confirms that the correct steel quality has been used when manufacturing the crane, that the welding is correct, and that the welders are properly certified. With the arrangement on a test stand, the survey also contains a functional test of the arrangement confirming that the SOLAS requirements are met.

A survey of the arrangement when installed on board the vessel
When the arrangement has been installed on board the vessel, a survey is conducted by the classification society. During this survey, the foundation of the arrangement in the deck, the bolting and any weldings are checked. Additionally, the survey also involves functional tests to confirm that the arrangement still fulfils the SOLAS requirements when installed on board the vessel. The survey also confirms that wires and other individual parts used in the system are approved and certified. Following this survey, certificates for the arrangement are issued.

When contracted to deliver the complete arrangement for the stores and rescue boat crane to ANNA MÆRSK, the manufacturer first recommended to the building yard that the rescue boat arrangement should be delivered without the swivel between the wire and the boat hook. However, by technical regulation[6] the Danish Maritime Authority required that all lifting appliances with hoist wire rope with a single part should be fitted with swivels to prevent the hoist wire rope from twisting. Therefore the building yard insisted on maintaining a the swivel in the system. The manufacturer therefore laid out the arrangement accordingly; choosing approved and certified standard parts for the swivel.

As per the previous description, the manufacturer of the rescue boat crane stores arrangement forwarded the drawings to the classification society for approval. The design drawings were approved by the classification society without remarks.

After the survey at the factory and the final survey on board the vessel, the arrangement was approved and certified without remarks.

[6] Technical regulation no. 12 of 12 October 2000

3.8 Metallurgical analysis of the swivel

Following the accident, the ship owner initiated a metallurgical analysis of the complete swivel system. The analysis was conducted by the Danish FORCE TECHNOLOGY institute. The report published following the analysis of the swivel system is attached to this accident report as appendix 1.

Below please find 'results', 'discussion' and 'conclusion' from the report (for references to the figures mentioned please see the full report):

Results

The visual appearance of the suspension is satisfactory. The parts are covered by a "crust" consisting of grease and corrosion products, but this is in accordance with the expectation for galvanized steel after long term exposure to sea air on the deck of a ship, c.f. Figure 4. The mechanical parts were freely movable and grease still present in the swivel has retained consistency and a light yellow brownish color.

As shown in Figure 5 (and Figure 1), the fork-end of the swivel opened up during use thus allowing the off-load hook eye to slip out of the suspension. Closer look at the opened leg of the shackle showed that the protruding parts of the lock split were sheared off, c.f. Figures 6 and 7. The fresh metallic appearances of the split shear fractures indicate that this happened in connection with the slipping incident. Otherwise the very reactive fracture surfaces would have attained a rusty appearance. The gouging/smearing marks at the end of the pin bolt also originates from the slipping incident as the off-load hook was forces out of engagement. Cutting up and freeing the remaining split ends as shown in Figure 8 revealed the split to be made of (magnetic) mild steel and the cross section in Figure 9 shows that the mild steel split, despite some superficial corrosion has retained sufficient cross sectional area to serve its purpose. The micro structure shown in Figure 10 confirms the material to be soft, mild steel. This type of splits may be electro-galvanized in the "as delivered" condition to offer some corrosion protection, but the superficial corrosion has removed any possible evidence of such protective coats.

One of the fork end legs was deformed in (outwards) bending. The resulting straining of the surface has caused the surface "crust" to spall thus exposing areas of bright appearing zinc rich surfaces. The same effects is observed in contact marks appearing in the hole edges as shown in Figures 11 and 12.

Figure 13 and 14 show gouging contact wear in the deformed leg with a striation pattern in the contact zone. The gouged surface appears to be covered by light rust thus suggesting it to be made some time prior to the lifeboat drop incident.

Figure 15 shows contact marks at the inside of the non-deformed fork leg. The position and bright metallic appearances suggests the marks to be related to the final separation of the hook eye from the suspension.

Vickers hardness testing shows a uniform hardness in the range 184 to 190 HV30. This corresponds to a tensile strength of 590 MPa. With an effective load carrying cross section of > 300 mm^2 the theoretical

breaking load would be in the order of 18 ton. The drawing in Figure 2 indicates the safe working load to be 1.63 ton thus the safety factor against rupture is very high.

Discussion

Figure 16 summarizes the observations made during visual examination. It is evident that that one of the fork end legs was deformed in bending. The same forces responsible for the bending has also sheared off the securing split in the pin thus allowing the fork to open up and let the hook eye slip out of engagement.

It has not been possible to identify the source of the fork leg opening force, but from presence of bright zinc in the high strain areas and the bright metallic shear fracture surface in the split it appears to have occurred close before, if not during, the final event.

Conclusion

The condition of the suspension at the time of the drop incident was satisfactory as judged from the general appearance of the various items in the suspension.

There is no indications that the strength of the fork end was inferior and there are no signs of material defects or deficiencies being causative or contributory to the failure.

4. ANALYSIS

4.1 The breakdown of the swivel

As a part of the rescue boat arrangement, a swivel was installed between the wire and the off-load hook.

As seen in figures 5 and 6 above, this swivel consisted of a fork end shackle and a green pin shackle. Both parts were approved and certified items. The intended way of mounting the swivel was with the fork end shackle pointing upwards towards the wire fall and the green pin shackle towards the off-load hook. On board ANNA MÆRSK, the swivel system was mounted in the opposite manner, i.e. the fork end shackle was connected directly to the off-load hook. It has not been possible to establish when this upside down mounting of the swivel first occurred.

The investigation board does not consider that the upside down mounting of the swivel had any impact on the strength of the system.

The pin in the green pin shackle was secured by a nut and a split pin. Thereby the nut was prevented from loosening and the pin from parting with the shackle. The pin in the turning part of the swivel had only one split pin in order to prevent the pin from moving out of the fork.

Following the accident, the swivel was found as seen in figure 5 above and it was still attached to the wire by the green pin shackle. It was apparent that the visible parts of the split pin on the fork end shackle pin had broken off thereby allowing the pin to work itself out of the fork.

The split pin was made of mild steel. Considering the environment in which it was supposed to fulfil its function, it is considered very likely that the surface of such a split pin has been exposed to and affected by the effects of the environment. These effects of exposure may have made it more difficult to observe any damage to the arrangement, including the split pin.

The breakdown was caused by the split pin failing. Due to the missing split pin, the fork end shackle pin was able to work itself out of the fork leg.

4.2 Regulation and maintenance

The required qualifications of the personnel involved in the maintenance and operation of the equipment covered by technical regulation no. 12 of 12 October 2000 were exclusively linked to crewmembers' positions on board. Thus masters, chief engineers, chief officers and 2nd engineers were considered qualified individuals solely due to their position on board. Apart from the certification required for having one of these positions on board, no further certification was required in relation to maintenance and operation of on-board cranes and lifting appliances covered by technical regulation no. 12 of 12 October 2000.

The maintenance of the rescue boat part of the unit was governed by the requirements given in the SOLAS Convention. SOLAS stipulates that equipment must be inspected and maintained weekly, annually and 5-yearly. The SOLAS Convention recommends that the annual and 5-yearly inspections/maintenance is conducted by qualified and certified service stations approved by the manu-

facturer of the equipment. However, as a global network of approved service stations is not yet deemed available, the requirement to have approved service stations conducting annual and 5-yearly inspections and maintenance is not mandatory. In Danish flagged vessels the Danish Maritime Authority has allowed masters and chief engineers to conduct annual and 5-yearly thorough testing and inspections of launching appliances for survival craft and rescue boats. The statement described in MSC/Circ. 1206, annex 1, chapter 15, to be issued by the manufacturer when such thorough inspections and servicing have been completed by the manufacturer's qualified personnel is therefore not mandatory on board Danish flagged vessels.

During a dry-docking in 2008, as part of the 5-yearly inspection of the rescue boat- and stores crane, a service station approved by the manufacturer was ordered to perform a load test of both the rescue boat- and the stores crane. All other previous and subsequent inspections were performed by the vessel's own crew from both the deck department and the engine department.

When studying the guidelines for inspections and maintenance given in the technical regulation and the SOLAS Convention respectively, the failing split pin was best covered by the guidelines given in SOLAS regarding weekly inspections.

Inspections and maintenance conducted as per technical regulation no. 12 of 12 October 2000 and the annual and 5-yearly inspections/maintenance conducted as per SOLAS were registered in the RDRM system. Weekly inspections/maintenance conducted as per SOLAS were registered in the paper file, the SOLAS Maintenance Manual, which was adapted to the individual vessel by the vessel's own crew.

The adaptation of the SOLAS Maintenance Manual to the individual vessel takes place over time and is partly dependent on the individual crew members performing the work and their attitude to the work and their previous experience.

On board ANNA MÆRSK, the SOLAS Maintenance Manual did not mention the swivel or the split pin as a specific item to be inspected.

5. CONCLUSIONS

5.1 The breakdown

The breakdown was caused by the split pin in the fork end shackle pin having sheared off, thereby allowing the fork end shackle pin to move out of one of the fork ends.

The effects to the split pin of having been exposed to the environment may have been contributing to the outer ends of the split pin finally tearing off. When this happened, there was no safety measure against the fork end shackle pin moving out of the fork. When the fork end shackle pin opened, the rescue boat fell to the water.

As indicated in the metallurgical analysis the hook arrangement was sound and not affected by corrosion. However, the arrangement showed signs of being exposed to the environment. These effects of exposure may have made it more difficult to observe any damage to the arrangement, including the split pin.

5.2 Approval and certification

When rescue boats, Suez boats etc. are being hoisted and lowered, they will often have their crew on board. The effectiveness of safety measures is therefore critical for the safety of the crewmembers on board.

The rescue boat arrangement was designed and certified with a swivel having only one fragile lock securing device (3 mm split pin). This indicates that there has not been sufficient focus on the safety critical nature of the equipment considering the intended use of the crane and the crane's exposure to the environment. The intended use is not only hoisting and lowering manned boats in emergency situations, but also in connection with drills and exercises.

This has been a contributing condition to the accident.

The swivel was constructed by using standard parts which were approved and certified, but not specifically for the safety critical purpose of hoisting and lowering manned boats. This has been a contributing condition to the accident.

5.3 Maintenance of safety critical equipment

Maintenance work was governed by the SOLAS Maintenance Manual, which was a non-controlled document individually adapted to each individual ship, by the generic RDRM system and by the DMA technical regulation. Furthermore, the maintenance work was carried out by several crewmembers from the engine and deck departments none of whom had, in the relevant documentation governing their work, the specific task of checking the swivel and its components.

Consequently, weekly inspections and maintenance of the swivel on each individual ship were to some extent influenced by the individual operation and experience of the crewmembers performing maintenance and checks.

Qualified individuals perform inspections and maintenance work and subsequently sign for and approve the equipment.

As per the technical regulation issued by the DMA, on board Danish flagged vessels senior officers are considered individuals qualified to maintain the on-board cranes exclusively because of their position. Thus, no specific qualifications regarding work with cranes are required.

Therefore senior officers can perform both the annual thorough inspections and the 5-yearly inspections without the need for participation by the manufacturer's qualified service station or for any subsequent approval by the vessel's classification society.
That inspections and maintenance of on board cranes is to some extent influenced by the individual operation and experience of the crewmembers performing the work, and that there is no requirement for specific qualifications, contribute to the way in which the maintenance of on-board cranes and lifting appliances is planned and conducted. The investigation board assesses that this is a contributing condition to why the attention of the crew was not on the maintenance of the swivel and its parts.

6. PREVENTIVE MEASURES TAKEN

As a direct consequence of the accident, the operator has ordered all its vessels to remove the jaw end swivel in the rescue boat arrangement where possible, i.e. where a non-twisting wire is used on the drum and the swivel therefore is not needed.

Following the accident, the operator has banned all exercises with crewmembers in the rescue boats temporarily. During exercises with rescue boats, the boats should be lowered and hoisted without crewmembers. Rescue boat crews should enter the rescue boat via the lowered gangway.

The operator will decide on a type of hook and subsequently use this hook throughout the fleet in order to increase uniformity as well as simplicity for the on-board crews.

The operator has reviewed the procedures and work instructions in the RDRM system and the Global Safety Management System (GSMS)

The operator is evaluating the possibilities of using external inspections of live-saving lifting appliances irrespective of the DMA allowance to have vessel's own senior officers conducting the inspection.

7. SAFETY RECOMMENDATIONS

The investigation board recommends that the Danish Maritime Authority considers whether it is appropriate to continue the practice of allowing a vessel's own crew to perform inspections and maintenance of cranes used for hoisting and lowering manned life boats and rescue boats.