ACCIDENT REPORT

Report on the investigation of the

derailment of the hatch-lid gantry crane on board

Blue Note

while alongside in Londonderry, Northern Ireland

22 July 2011

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

LESS SERIOUS MARINE CASUALTY REPORT NO 7/2012 March 2012

Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AB	-	Able seaman
BST	-	British summer time
COSWP	-	Code of Safe Working Practices
EU	-	European Union
GL	-	Germanischer Lloyd
ILO	-	International Labour Organization
IMO	-	International Maritime Organization
ISM	-	International management code for the safe operation of ships and for pollution prevention (International Safety Management (ISM) Code adopted November 1993)
kg	-	kilogram
LOLER	-	The Merchant Shipping (Lifting Operations and Lifting Equipment) Regulations 2006 (SI 2184/2006)
m	-	metres
m3	-	cubic metres
MARPOL	-	International Convention for the Prevention of Pollution from Ships
MCA	-	Maritime and Coastguard Agency
MED	-	Marine Equipment Directive (96/98/EC)
MGN	-	Marine Guidance Note
MIN	-	Marine Information Note
mm	-	millimetre
MSC	-	Maritime Safety Committee
PMS	-	Planned Maintenance System
PUWER	-	The Merchant Shipping (Provision and Use of Work Equipment) Regulations 2006 (SI 2183:2006)
SI	-	Statutory Instrument
SMS	-	Safety Management System

SOLAS	-	International Convention for the Safety of Life at Sea
t	-	tonnes
UTC	-	Universal Time, Co-ordinated

Times: All times used in this report are BST unless otherwise stated

Image courtesy of Juergen Braker

Blue Note

SYNOPSIS

On 22 July 2011, the hatch-lid gantry crane on board the dry cargo vessel *Blue Note* derailed while it was carrying a single hatch-lid to its stowed position in preparation for discharging cargo. The derailment caused the chief officer, who had been riding on one of the crane's wheel units, to be thrown overboard; an able seaman, who had been riding on another wheel unit, to be left hanging by his hands over the 8.4m deep hold; and the second officer, who was operating the crane, to fall to the deck of the control platform. All three crewmen were lucky to escape with only minor injuries.

The MAIB investigation found the most likely cause of the accident was that the port side lifting hooks of the gantry crane were not correctly engaged with the hatch-lid's sockets during an operation to move the lid aft to its open stowage position. This led to the port hooks becoming disengaged as the lid was being moved, causing it to fall and pivot about the starboard lifting hooks. The hatch-lid struck the starboard legs of the gantry crane, causing it to derail while the port side continued to fall, finally coming to rest at the bottom of the cargo hold.

Safety issues which contributed to the accident included:

- The design of the crane made it difficult for ships' staff to verify if the lifting hooks were correctly engaged in the lifting sockets provided on the hatch-lids.
- There was no manufacturer's instruction manual for the crane on board *Blue Note.*
- Upkeep of the crane was not a specific part of the ship's planned maintenance system.
- There were no records held on board of maintenance or repairs to the crane.
- There was no risk assessment covering the operation of the crane and movement of the hatch-lids. As a consequence, ship's staff had adopted poorly considered working procedures that focused on expediency rather than safety.

A recommendation has been made to the owners of *Blue Note* which is designed to promote general safe working practices across its fleet while specifically addressing the safety issues identified relating to the operation of the gantry crane. Recommendations have also been made to the manufacturer of the gantry crane which seek to ensure that ship owners and ships' staff are provided with clear guidance on the safe operation and maintenance of this equipment.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *BLUE NOTE* AND ACCIDENT

SHIP PARTICULARS

Vessel's name	*Blue Note*
Flag	Antigua and Barbuda
Classification society	Germanischer Lloyd
IMO number	9491915
Type	Dry cargo vessel
Registered owner	Meyering B Schiffahrts KG
Manager(s)	Reederei-Meyering GmbH
Construction	Steel
Length overall	89.96m
Gross tonnage	3845
Minimum safe manning	8

VOYAGE PARTICULARS

Port of departure	Derince, Turkey
Port of arrival	Londonderry, UK
Type of voyage	Not applicable
Cargo information	Soda ash
Manning	9

MARINE CASUALTY INFORMATION

Date and time	22 July 2011, 14:20 BST
Type of marine casualty or incident	Less Serious Marine Casualty
Location of incident	Londonderry
Place on board	Aft section of main deck
Injuries/fatalities	3 minor injuries
Damage/environmental impact	No external damage
Ship operation	Cargo operations
Voyage segment	Alongside
External & internal environment	Daylight, light winds, nil precipitation
Persons on board	9

1.2 BACKGROUND

Blue Note was one of three identical sister ships that formed part of a fleet of six dry cargo ships operated by Reederei-Meyering GmbH. The company's shipping activity began in 1977 and its vessels traded throughout Europe and North Africa. *Blue Note* was fitted with a gantry crane that could be moved along the whole length of the cargo hold on rails that were secured to the top of the hatch coaming in order to remove or replace cargo hatch-lids.

1.3 NARRATIVE

1.3.1 Cargo operations

At 0600 on 21 July 2011, *Blue Note* arrived in Londonderry to discharge its cargo of soda ash. The two movable bulkheads in the hold were positioned right aft so the ship was in its single hold configuration. At 1025, with the discharge well underway, a new chief officer joined the ship for a short handover with the outgoing chief officer, who was due to leave the following day. This was the new chief officer's first contract with Reederei-Meyering GmbH, however he had previously worked on six other ships with hatch-lid gantry crane arrangements similar to those on *Blue Note.*

The day was spent with the two chief officers working through their handover while cargo operations continued. At 1825 the stevedores suspended discharge operations for the day, and the outgoing chief officer was watched by his relief as he used the gantry crane to close the hatch-lids. The outgoing chief officer used this opportunity to explain the operation of the crane and guided his relief through the control system, the lifting mechanism and the lifting procedure. He informed the new chief officer that the crane's maintenance was recorded in a 3-monthly deck maintenance checklist and that one wire had been changed several weeks earlier.

1.3.2 Crane operating procedures on board

As was normal procedure on board *Blue Note*, the outgoing chief officer directed the hatch closure while riding on the starboard, forward wheel unit of the gantry crane. This position was directly below the third officer, who was operating the crane from the upper control platform. An able seaman (AB) stood on the port side, forward wheel unit.

When lifting a hatch-lid, the procedure used on board was for the third officer to drive the crane to the approximate position of the lid to be lifted and lower the spreader until it rested on top of the lid. He would then move the crane forward until the hooks made contact with the lifting sockets on the side of the hatch-lid. This was taken to indicate that the hooks were in position to engage with the sockets and the lid could be lifted safely. When the spreader was raised and the wires had taken the weight of the lid, the third officer would stop lifting so that the hooks could be visually checked from below. The AB on the port wheel unit was required to check that the two hooks on the port side were fully engaged, and signal to the chief officer once he was satisfied. The chief officer similarly checked the starboard side, and once both sides had been checked, signalled to the third officer to continue with the lift. The third officer would then raise the lid to the appropriate height and drive the crane to the position where the lid was to be stacked.

1.3.3 The accident

At 0800 the following day, the outgoing chief officer watched his relief open hatch-lids 3, 4 and 5 in preparation for the resumption of the cargo discharge. The lids were stacked in the designated storage position at the forward end of the ship. The relief chief officer (hereafter known as the chief officer) followed his predecessor's practice of riding on the starboard, forward wheel unit, with an AB on the port wheel unit and the third officer at the controls. Discharge of the cargo resumed at 0900. By 1000 the three men had also opened hatch-lids 6 and 7; this time without any supervision from the outgoing chief officer.

At 1300 the stevedores stopped for their lunch break. Being conscious that the soda ash cargo could cake if exposed to moisture, the chief officer, third officer and AB set about replacing the hatch-lids on the forward part of the hold. When this was done, they began to open up the after part of the hold in anticipation of the stevedores continuing with the discharge. Hatch-lids 11 then 9 and then 10 were removed and stacked in their designated stowage position, aft of the hold and just forward of the superstructure.

At approximately 1420 the crane was positioned above hatch-lid number 8. The normal lifting procedure was followed: the AB signalled to the chief officer that the port hooks were engaged and, satisfied that the starboard hooks were engaged, the chief officer signalled to the third officer to continue lifting. The third officer then raised the lid and began to drive the crane aft towards the position of the stacked lids.

The crane had travelled approximately 10 metres when the port side of the lid fell from the lifting hooks. The hatch-lid pivoted momentarily on the starboard hooks before the additional weight bent the starboard lifting sockets and the lid crashed into the starboard legs of the crane and came to rest on the bottom of the hold **(Figure 1)**. The crane derailed and three of the four wheels were detached. The

Figure 1: Position of crane and hatch-lid following the accident

chief officer was thrown overboard and into the water between the quayside and the ship; the AB was left hanging by his hands over the cargo hold; and the third officer fell onto his knees at the control station. All three men suffered minor injuries and were able to get themselves to safety without assistance.

Most witnesses to the accident thought that the crane gantry was travelling along the rails when the hatch-lid fell. However, some thought that the crane might have stopped to check that the hatch-lid had been lifted sufficiently high to clear the other stacked lids before approaching them.

1.4 *BLUE NOTE*

Blue Note was built by Israel Shipyards Ltd of Haifa in 2010 as one of a series of vessels that the shipyard was building for general sale without having a specific buyer in place. Reederei-Meyering GmbH had already purchased two sister vessels before buying *Blue Note*. As the company had not commissioned any of the builds, it had little input into the design or fitout of these vessels.

1.5 THE GANTRY CRANE

1.5.1 Background

Israel Shipyards Ltd contracted Mariner Ship's Equipment of Istanbul to supply the cranes for the series of new build vessels that included *Blue Note*. *Blue Note*'s crane **(Figure 2)** was required to lift the 11 hatch-lids that covered its hold and, when configured to do so, move the two movable bulkheads. The crane was built to a standard design which Mariner Ship's Equipment could adapt to meet a safe working load appropriate for the vessel it was to serve. As of October 2011, this design of crane had been supplied to 42 ships worldwide.

Figure 2: The gantry crane

The crane was manufactured in Turkey and assembled in Israel by the shipyard, under the supervision of a Mariner Ship's Equipment representative.

1.5.2 Design overview

The electro-hydraulically driven gantry crane had a safe working load of 14t and was used to lift the hatch-lids and movable bulkheads that weighed 11t and 10t respectively.

The crane was driven from controls situated on the starboard side of its upper platform **(Figure 3)**. One lever raised and lowered the lifting spreader and a second drove the crane forward and aft along its rails. Apart from the labelling of the control levers, there were no operating instructions at the control position.

Figure 3: Control station

The spreader was suspended below the control platform by four wires and was raised and lowered by a single hydraulic ram jigger winch powered from the same hydraulic system that drove the wheels **(Figures 4** and **5)**. The lengths of the lifting wires could be altered by adjusting bottle screws in order to keep the spreader parallel to the hatch-lids. Four hooks were permanently fixed to the spreader such that they could be engaged with the hatch-lid lifting sockets.

The wheel units were positioned at the outermost part of each of the four corners of the gantry. Each wheel unit was joined to the crane by way of a central pin measuring 30mm length and approximately 40mm diameter **(Figure 6)**. This pin was inserted into a hole at the centre of each wheel casing and held in place by eight bolts, each with a threaded length of 65mm and 16mm diameter **(Figure 7)**. The designers confirmed that the central pin was intended to bear the load and that the bolts were unlikely to withstand sideways shock loadings, such as those generated by a falling hatch-lid.

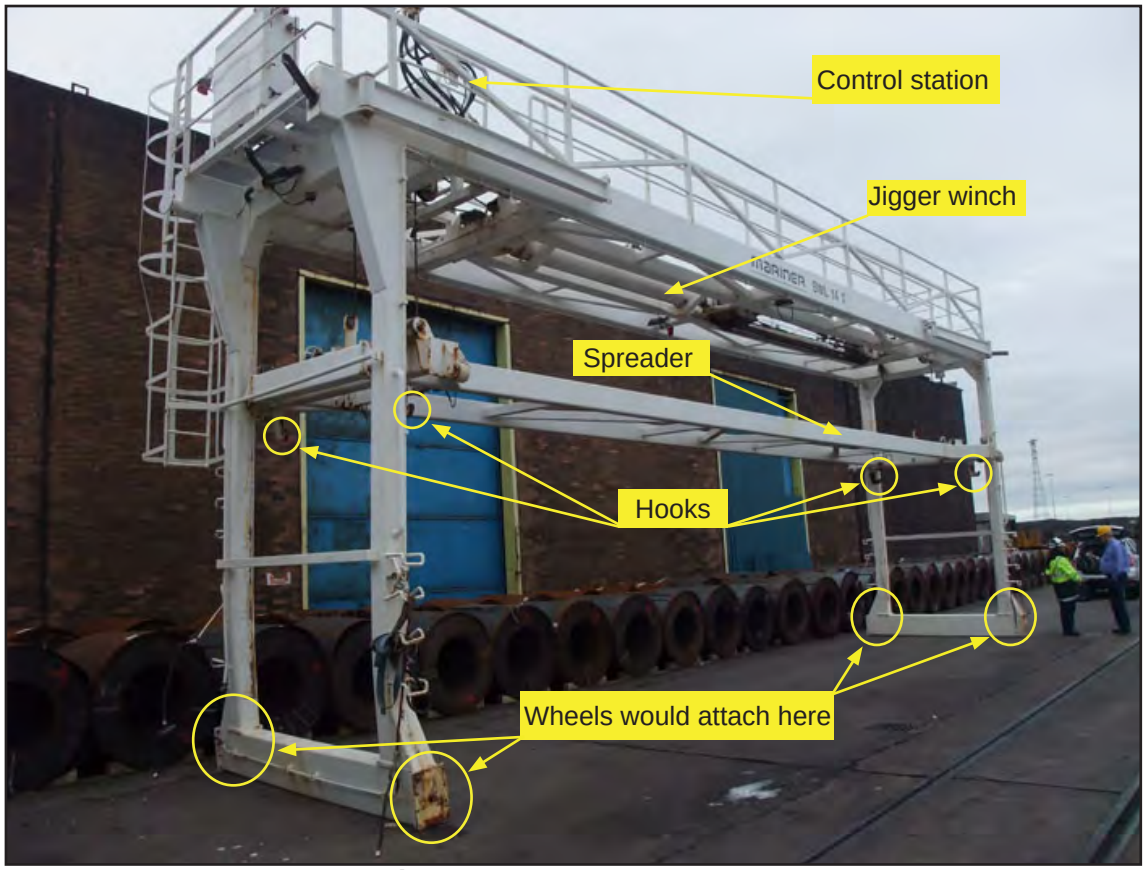

Figure 4: Crane arrangement

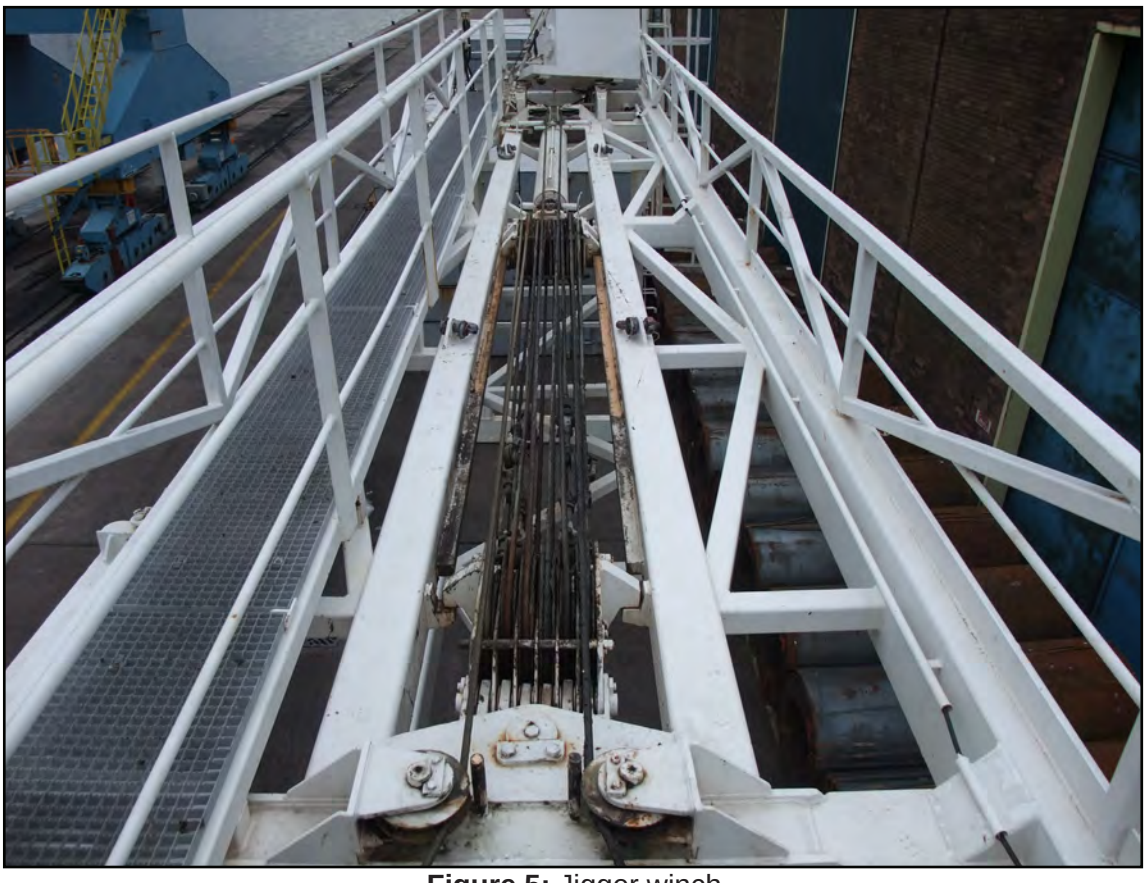

Figure 5: Jigger winch

Figure 6: Load bearing pin

Figure 7: Wheel unit and securing point

1.5.3 Intended operation of the crane

The manufacturer's instructions stated that the crane could be operated with two men: one at the controls and one at the hatch coaming level to ensure that the lifting hooks were engaged. The crew of *Blue Note* operated the crane with three men as they felt this was a more efficient way to check both the port and starboard hooks.

It was intended that the person checking that the hooks had engaged would stand on the deck. However, this was difficult to achieve on *Blue Note* because the height of the hatch coaming obscured the view of the lifting hooks. Consequently the crew stood on the forward wheel units to check that the hooks were engaged. They did this by holding on to the hand-holds and leaning out around the structure of the crane to get the best view of the lifting sockets on the side of the hatch-lid **(Figure 8)**. There was no platform or ladder fixed to the crane that would have enabled them to view the hooks from a safer position.

Figure 8: Demonstration of checking the hooks (*Blue Carmel*)

The wheel units were not meant to be stood on while the gantry was being moved. However, once a hatch-lid had been lifted the crew considered it to be more convenient to ride on the wheel units until the crane reached the position where the lid was to be placed. *Blue Note*'s crew did not wear safety harnesses or lifejackets, either when leaning out to check that the hooks were engaged or when riding on the wheel units.

1.5.4 Condition of the crane following the accident

Photographs of the crane taken immediately after the accident showed that it had derailed to starboard and that the hatch-lid had come to rest with the port side on the bottom of the hold. Only the port side after wheel was still attached to the crane.

Four witness marks were found on the rails along the hatch coaming, each corresponding with the position of one of the gantry wheels. The shape of the marks suggested that the wheel units had been pulled off the rails to starboard and had been formed by the resulting impact as the gantry had fallen.

Following discharge of all the cargo, the ship sailed to Newport, South Wales, where the crane was lifted ashore. It was inspected by MAIB inspectors on 25 July 2011, by which time all of the wheels had been removed from the crane.

Both of the starboard side vertical pillars of the gantry crane were bent from the impact of the hatch-lid **(Figure 9)**. Several hydraulic hose assemblies had been damaged and the hydraulic power pack had been displaced. The hour counter on the electrical panel next to the control station read 360 hours.

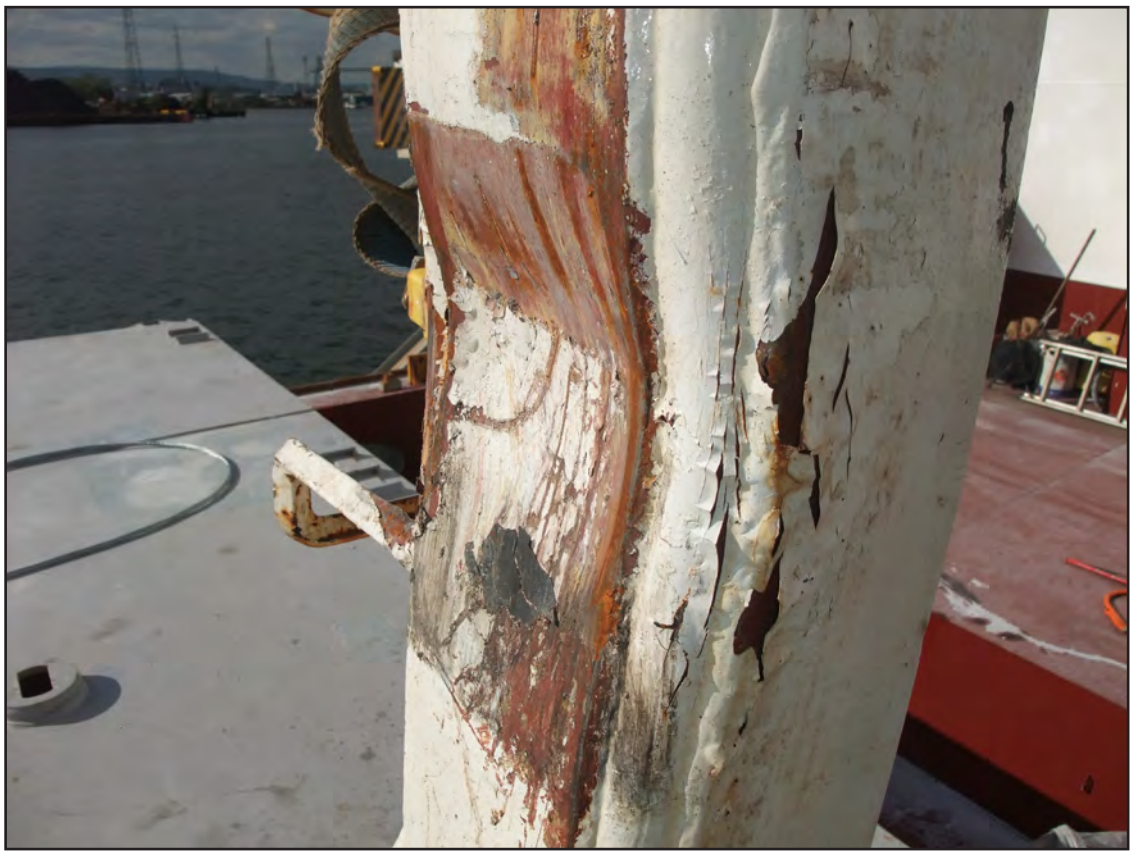

Figure 9: Impact damage on the starboard, forward vertical pillar

It was noted that the spreader was not level (parallel with the gantry), with the forward end sitting lower than the after end **(Figure 10)**. It was found that none of the locking nuts on the bottle screws that adjusted the lengths of the spreader's wires had been secured **(Figure 11)**.

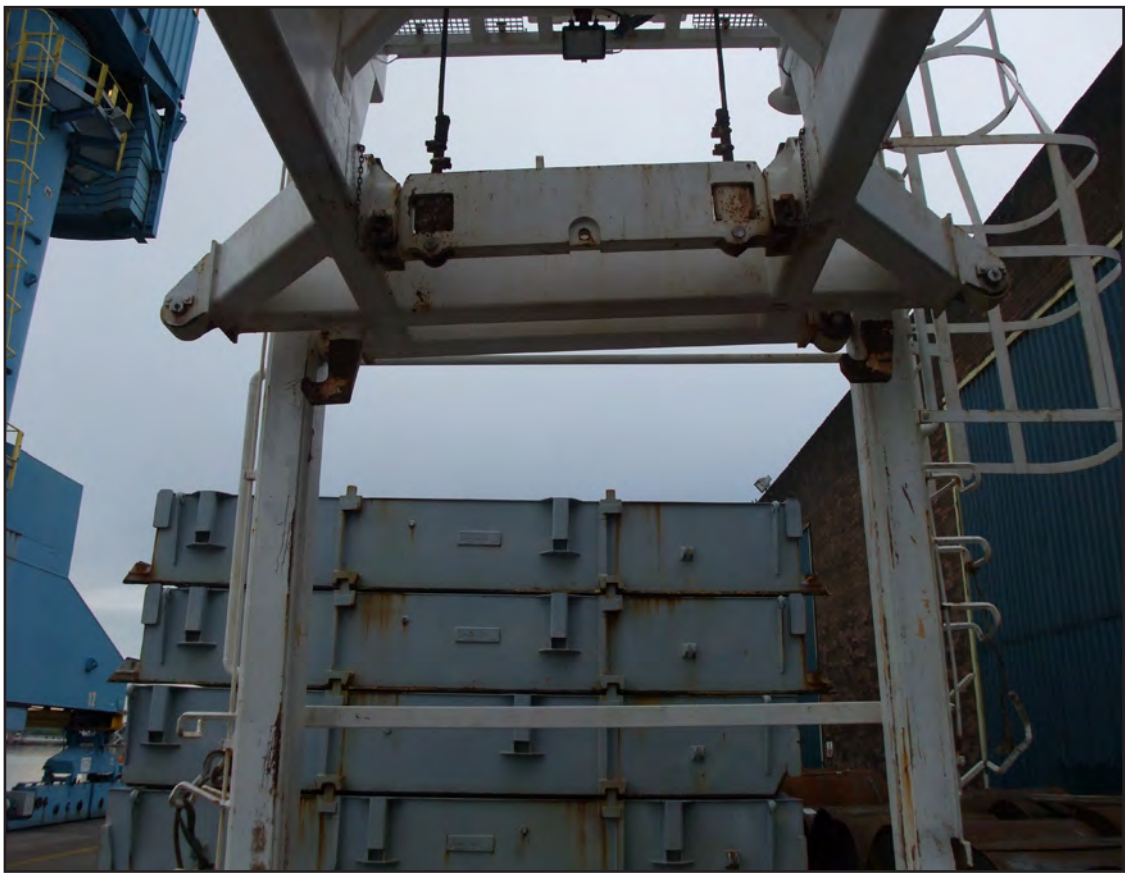

Figure 10: Incline of the spreader

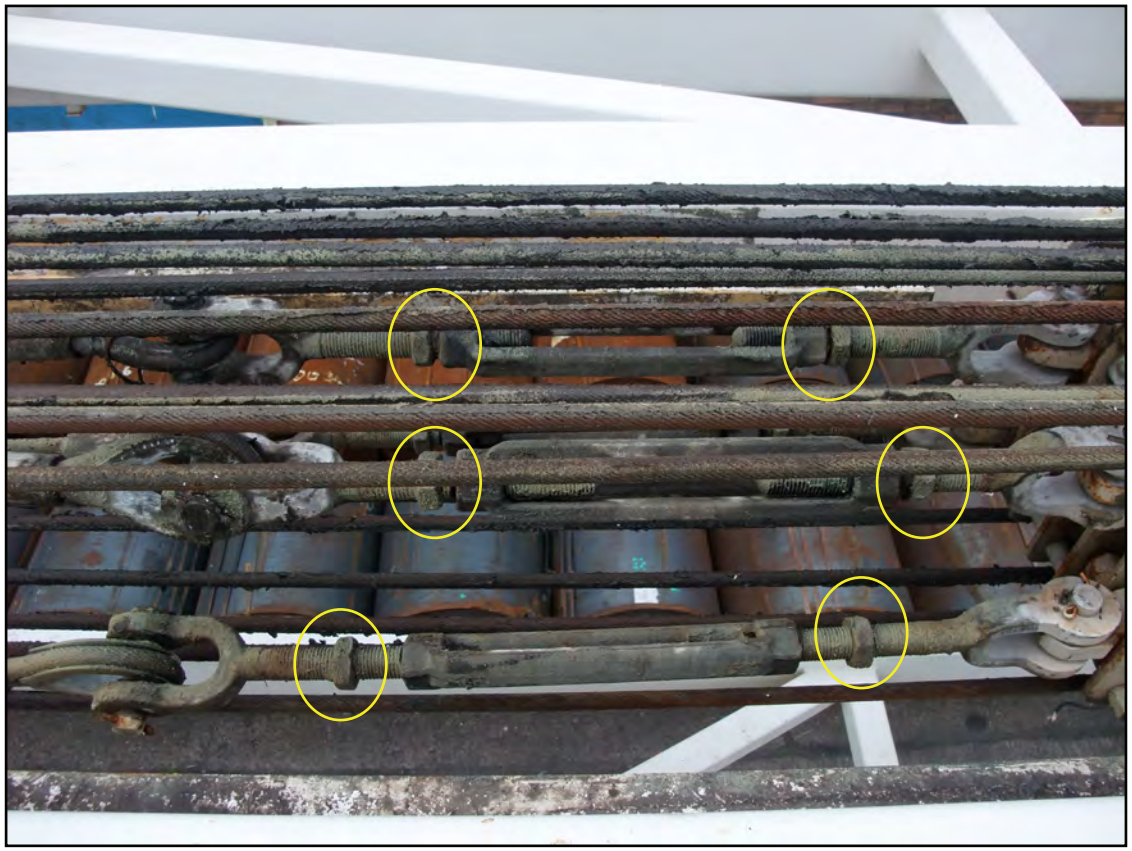

Figure 11: Bottle screws and locking nuts

The four hooks were still firmly attached to the spreader. The end of each hook was found to be approximately 15mm shorter than in the original design drawings **(Figure 12)** and 25mm shorter than a hook that was intended for use in another crane which was presented to MAIB inspectors during a visit to the Mariner Ship's Equipment factory in Turkey **(Figure 13)**.

Figure 12: Port aft hook

Figure 13: Latest hook design of Mariner Ship's Equipment

1.5.5 Bolt analysis

Some of the fractured bolts that had secured the four wheels to the crane unit were recovered from the accident scene and handed to MAIB inspectors for analysis. Unfortunately they were not kept separate; it was therefore not possible to identify which bolts had come from each of the four wheels.

The analysis carried out on behalf of the MAIB **(Annex A)** identified that 11 of the 16 fractured bolts showed signs of fatigue cracking, and corrosion patterns indicated that a significant number of bolts had probably begun to develop fractures before the accident occurred.

1.6 REGULATIONS FOR LIFTING EQUIPMENT

Blue Note was built in Israel, registered in Antigua and Barbuda, classed, owned and managed from Germany, carried a crane designed and built in Turkey and was visiting a United Kingdom port when the accident happened. There were therefore a number of regulations that were applicable to the crane.

1.6.1 International

The International Labour Organization (ILO) adopted the Occupational Safety and Health (Dock Work) Convention in 1979, known by its sequential number 'ILO 152'. Entering into force in 1981, ILO 152 applied to *"...all and any part of the work of loading or unloading a ship".* The most relevant aspects of ILO 152 are Articles 21 to 25. These are summarised as:

- Equipment used for lifting operations is to be of good design and construction, of adequate strength, properly installed and maintained.
- Lifting appliances are to be inspected regularly before use.
- Records of tests and inspections are to be kept in a lifting gear register to provide evidence of the safe condition of lifting appliances.

Although widely accepted as the principal international requirement for lifting equipment in the shipping industry, ILO 152 was intended to protect shore-based dock workers, and it only applies to equipment that is used to load or unload a ship.

1.6.2 European

The European Union (EU) has issued a number of directives setting minimum health and safety standards for workers, including requirements for work equipment. The most relevant of these directives, (89/391EEC, 89/655EEC and 95/63/EC[1]), have introduced obligations on employers to provide training and written instructions on

[1] Measures to encourage improvement in the safety and health of workers at work (89/391/EEC)

Minimum safety and health requirements for the use of work equipment by workers at work (89/655/EEC

Minimum safety and health requirements for the use of work equipment by workers at work (95/63/EC), containing amendments to 89/655/EC

work equipment and, specifically, equipment used for lifting loads. Directive (89/655/EEC), section 11 defines the employer's obligations associated with the use of work equipment, and includes the following key points:

- *Article 6.1 The employer shall take the measures necessary to ensure that workers have at their disposal adequate information and, where appropriate, written instructions on the work equipment used at work.*

- *Article 7 Workers given the task of using work equipment receive adequate training, including training on any risks which such use may entail.*

1.6.3 Germanischer Lloyd

The manufacturer's manual confirmed that the materials and construction standards used for the crane were in compliance with Germanischer Lloyd's (GL) rules and regulations and adhered to the Production Standards of the German Shipbuilding Industry (VSM, 6. Edition: 2003). GL had subsequently approved the drawings of the crane for its ability to carry the design load and carried out the required load testing when the crane was commissioned into service.

1.6.4 Antigua and Barbuda

The Antigua and Barbuda registry did not have any additional lifting appliance regulations that *Blue Note*'s crane had to comply with.

1.6.5 United Kingdom

United Kingdom Merchant Shipping Regulations enact EU directives for the minimum health and safety standards for workers. Relevant to this accident is the Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations (SI 2006:2184), known as LOLER.

This regulation applies to United Kingdom registered ships and non United Kingdom registered ships that are operating within United Kingdom territorial waters, and was therefore applicable to *Blue Note.*

The key requirements that are pertinent are:

- *The employer should ensure that every lifting operation involving lifting equipment is carried out in a safe manner.*

- *The employer shall ensure that adequate and effective procedures and safety measures are established to ensure the safety of workers during lifting operations.*

A surveyor from the UK's Maritime and Coastguard Agency (MCA) attended *Blue Note* just before the accident to conduct a routine Port State Control inspection. He left the vessel before the accident occurred, but returned the following day after he had been told about the failure of the crane.

Port state control inspections focus on compliance with key International Maritime Organization (IMO) codes and conventions, such as the International Convention for the Safety of Life At Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships (MARPOL) or The International Safety Management (ISM) code. They do not assess a vessel's compliance with national legislation that is applicable to foreign flag vessels visiting those waters.

On his initial visit to *Blue Note* the MCA surveyor noted the following deficiencies:

- Insulation on the purifier was covered in oil (to be corrected within 14 days)
- The sludge discharge from the heavy fuel oil purifier bypassed the pump to the sludge drain line (to be corrected within 3 months).

On his second inspection, the MCA surveyor noted the following additional deficiencies:

- Damaged hatch-lid (to be repaired before the vessel sailed)
- Damaged crane (to be repaired at the next port)
- Missing instructions on the safe use of the crane (to be in place at the next port)
- Missing instructions for cargo operations (to be in place within three months).

1.7 SAFETY MANAGEMENT SYSTEM

1.7.1 Application

The International Safety Management (ISM)[2] code requires ship operators to have a safety management system for shipboard operations and for the planned maintenance of equipment.

In 2005 Reederei-Meyering GmbH contracted Guideline GmbH of Bremen to produce its safety management system and to carry out routine internal audits to ensure the company's compliance with the ISM code. In February 2011, this relationship was terminated following *Blue Note*'s failure of an external ISM audit. A new provider, MARCARE, was appointed in April 2011. At the time of the accident, MARCARE had not visited *Blue Note* or provided Reederei-Meyering GmbH with a new safety management system.

1.7.2 ISM audits

ISM audit details relevant to this accident are:

- November 2010 - External audit by GL
    - One major non-conformity due to the absence of a planned maintenance system.
    - 3 month short term Safety Management Certificate issued.

[2] International management code for the safe operation of ships and for pollution prevention (International Safety Management (ISM) Code adopted November 1993

- February 2011- internal audit conducted by Guideline GmbH **(Annex B)**

  - Risk assessments and maintenance of the ship and equipment reported as being checked.
  - Seven non-conformities or observations recorded, six related to incorrect entries in logbooks or forms in use, and one concerned no bunkering procedure on board.

- February 2011 - external audit conducted by GL

  - One major non-conformity was raised because there was no planned maintenance system as required by the ISM manual. This was downgraded to a non-conformity when the office sent instructions during the audit.
  - Risk assessments were found to be incomplete and carried out by the chief officer instead of the master as detailed in the safety management system
  - 3 month short term Safety Management Certificate issued.

- March 2011 - external audit conducted by GL

  - Three non-conformities raised including maintenance activities that had not been recorded or were overdue.
  - 5 month short term Safety Management Certificate issued.

1.7.3 Training

Reederei-Meyering GmbH required all new crew to complete a '*Familiarisation with duty and emergency preparedness*' form **(Annex C)**. The first seven points on the form related to emergency procedures, and none of the remaining seven points specifically related to familiarisation with the crane.

All of the current crew members who operated the crane had been trained in its use by other crew members, either during their handover periods before commencing duties or from fellow crew members once the ship had sailed. This training was not recorded and those giving the instruction did not consult a checklist or operator's manual to ensure that all areas of safe operation were covered.

1.7.4 Maintenance

Mariner Ship's Equipment provided the shipyard with the crane's operating manual to supply to the vessel's owner. The manual contained detailed maintenance instructions which were summarised in a two page table **(Annex D)**. Neither the manual nor any excerpts from the manual concerning maintenance procedures were on board *Blue Note* at the time of the accident.

Blue Note's crew did not have a programme of maintenance assigned specifically to the crane, but considered it to be part of the general deck maintenance list that was completed every 3 months **(Annex E)**, referred to in the chief officer's handover.

The only part of this list that was applicable to the crane was the weekly greasing of deck items. None of the following specific tasks that were required by the crane manufacturer's maintenance schedule were included on the deck maintenance list:

- Major steel parts of the crane inspected every 2 months.
- After the first 50 hours of operation and at every 200 hours (or every 2 months, whichever comes first), all bolted joints to be visually inspected and any bolt that has slackened, to be overhauled and tightened up.
- Every 6 months or every 500 hours the rope must be examined for wear and tear.
- Every 2 months the machinery to be checked for loose bolts and cracks. Rope sheaves, slide ways and rope fixing must be checked and the gear and hydraulic system examined for cleanliness and leaks.
- Hydraulic oil analysis to be done every 6 months. If no analysis is done, the oil is to be changed every 2 years or a maximum of 1500 hours of operation. The oil filter cartridge to be changed every 1000 hours.
- Grease to be applied to grease nipples, axles, drive chain gears and chain every 100 hours or every 2 months.
- Every 2 months the wire ropes to be lubricated with suitable water resistant grease.
- The lifting cylinder to be greased monthly.
- The insulation resistance of the motor and motor heater to be checked weekly.
- Before starting the crane, or every week, whichever comes first, check lamps, handles and cover condition.

Any crane maintenance that was carried out by the crew was not recorded on board. Approximately 4 to 6 weeks before the accident, one wire was changed on the crane. There was no record of this, but as far as any of the crew could recall, that was the last time when the bottle screws that altered the lengths of the four wires, would have been adjusted.

1.7.5 Risk assessments

The safety management system stated that the master was responsible for performing risk assessments **(Annex F)**. However, none of *Blue Note*'s officers or crew was aware of any risk assessments on board, and none could be provided to the attending MAIB inspectors. The internal and external audit reports of February 2011 suggested that some form of risk assessments had been on board at that time. The internal audit carried out by Guideline GmbH had the section marked *Risk assessments* and *maintenance of the ship and equipment* ticked without comment. The external audit report carried out by GL stated that risk assessments were '*incomplete and carried out by the chief officer*'. None of the crew had referred to a risk assessment before operating the gantry crane while the vessel was in Londonderry.

1.8 *BLUE CARMEL*

Blue Carmel, a sister ship to *Blue Note,* was visited by MAIB inspectors to witness a similar gantry crane in operation. Several of the safety issues that had been identified from the accident on *Blue Note* were also seen in the operation of the crane on *Blue Carmel.* These included:

- The four lifting hooks were shorter than shown in the design drawings
- The joints between the wheel units and the crane were showing signs of flexing **(Figure 14)** and hence cyclic fatigue loading
- There were no records of maintenance or a plan for maintenance of the crane
- The crew operated the crane in exactly the same way as *Blue Note*'s crew: exposing themselves to harm when riding on the wheels or when checking to see if the hooks were engaged.

An additional point of note was the manner in which the crane came to a halt. When the crane travel was stopped or when the operator was adjusting its position prior to a lift, the movement was sudden and jerky.

Figure 14: Cracked paint indicating movement between wheel unit and crane (*Blue Carmel*)

1.9 OTHER ACCIDENTS INVOLVING NON-CARGO HANDLING CRANES

In 2010 MAIB published a report into the failure of the non-cargo handling crane on board *Sand Falcon* and issued a safety flyer to the shipping industry highlighting safety lessons. These included the importance of good planned maintenance and proper risk assessment **(Annex G)**.

Included in the *Sand Falcon* report was a tabulated summary of accidents involving the failure of non-cargo handling cranes reported to MAIB since 2001. This has been updated and annexed to this report **(Annex H)**.

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 FATIGUE

There is no evidence that any of the crew were suffering from fatigue and, therefore, it is not considered to be a contributing factor to this accident

2.3 FAILURE MODE

2.3.1 Overview

It was not immediately clear from the reports of eyewitnesses exactly why the crane had derailed, or at what point the port side of the hatch-lid had fallen from the lifting hooks. Therefore several possible causes of the derailment were considered. These included:

- The gantry legs splaying apart under excessive weight.
- The hatch-lid that was being transported making contact with the stacked lids at the aft end of the vessel which then dislodged it from the crane's lifting hooks and caused the gantry to derail.
- One of the four lifting hooks failing, causing the lid to drop and the shift in weight or the falling lid to then derail the gantry.
- A seized wheel or a fouled rail creating a torque moment as the crane attempted to travel in the fore and aft direction, causing one side to climb up onto its rail and derail.
- A wheel unit detaching from one of the crane gantry's legs.
- One or more of the crane's four lifting hooks not being fully engaged into the sockets of the hatch-lid, leading it to detach from the hooks and fall if subjected to any sudden movement or force.

2.3.2 Eliminated causes

Inspection of the crane following the accident confirmed that the gantry legs did not splay apart. Furthermore, the crane was carrying a single hatch-lid that weighed 11 tonnes and was well within its safe working limits.

Photographs taken immediately after the derailment show that the hatch-lid that was being transported was still several metres short of the stack of stowed hatch-lids **(Figure 15)**. The two did not make contact with each other and this was not the cause of the derailment.

Figure 15: Position of the fallen lid in relation to the stacked lids

Although the ends of the four crane hooks were shorter than originally designed, due to either wear in service or as part of the manufacturing process, they remained firmly fixed to the spreader of the gantry crane, and none had failed.

One of the crane's four wheels was lost overboard and, despite a search being conducted, could not be recovered. However, the remaining three wheels were found to be in good working condition, and there was no evidence to suggest a wheel might have become seized. The crane's rails were inspected and found to be in good condition. The soda ash cargo that was being discharged in Londonderry, even in its hardened state, would not have been sufficient in quantity or hardness to cause the crane to derail. Neither the seized wheel nor the fouled rail scenarios could be supported by eyewitness accounts or damage markings, and both were dismissed as possible causes.

It was concluded that the remaining potential causes of derailment were either a wheel unit detaching from the gantry, the hatch-lid falling off the lifting hooks, or a combination of both.

2.3.3 Detached wheel caused by failure of the securing bolts due to fatigue

The crane's maintenance schedule **(Annex D)** required that the wheel securing bolts had to be kept tight so that the forces were borne by the much larger central pin. Any flexing in the joint would cause the load to be transferred to the bolts; cycling of this load would lead to fatigue stresses accumulating in the wheel securing bolts,

which could lead to premature failure. The lack of any planned maintenance system, instructions or history for the gantry crane on *Blue Note* strongly indicate that the likelihood of the bolts being routinely checked, and tightened where necessary, was slim. Analysis of the bolts indicated fatigue fractures which, because of the amount of corrosion present, must have existed before the accident happened showing that flexing must have occurred. It was therefore considered that one, or more, wheel units might have detached from the gantry, causing it to derail and drop the hatch-lid in the process.

However, none of the eye witness accounts suggested that the wheels detached before the hatch-lid fell. Two of the crew were standing on the wheel units at the time, and neither of them were aware of a wheel coming off the gantry until after the accident. If the wheels had detached, it could be expected that the gantry would fall vertically and strike the rails a short distance below. Such an impact would have left witness marks on both the rails and gantry. The only witness marks that could be found were on the side of the rails, and strongly indicated that all four wheels were pulled to starboard and left the rails simultaneously.

There was little possibility of the wheels remaining attached to the gantry once the securing bolts were subjected to the extra loading imposed on them by the falling hatch-lid, or the gantry's impact with the deck. It is therefore considered much more likely that the wheels detached as a result of the derailment and subsequent impact.

2.3.4 Hatch-lid disengaging from the lifting hooks

There were several factors that increased the chances of the hatch-lid disengaging from the lifting hooks and being able to fall. Firstly, it was difficult to see if the lifting hooks were properly engaged in the lifting sockets from a position standing on the forward wheels. The reduced height of the hook and the lack of any positive indication that the hooks were correctly engaged into the hatch-lid's lifting sockets, meant there was an increased risk that a hook which was not fully engaged in its socket might not be seen.

Neither of the spreaders on *Blue Note* or *Blue Carmel* was parallel to the gantry. This was inevitable as the four lifting wires would have stretched at slightly different rates in service. However, it was intended that the bottle screws should be adjusted to take up this difference and allow the spreader to be kept parallel. This had not been done on *Blue Carmel*, and if they had been set on *Blue Note*, because the locking nuts had not been secured, any vibration that occurred while the ship was on passage and the wires were slack would have allowed the bottle screws to move.

The effect of the spreader not being parallel to the gantry would have caused the lifting hooks to be at different heights relative to the hatch-lid. This, in turn, would have meant that the hooks engaged with the lifting sockets a varying amount and would not have borne an equal proportion of the load. It is conceivable, in an extreme case, that one of the hooks did not carry any load at all. The risk of a hatch-lid then slipping off a hook completely would also have been exacerbated by the spreader having a slight forward incline and the jerky movement of the crane when coming to a halt.

2.3.5 Summary

The most likely cause of the accident is that one or both of the port side hooks was not fully engaged, and this was not seen by the AB. The AB incorrectly reported to the chief officer that the hooks were engaged, and this was passed on to the third officer. The hatch-lid was lifted and the crane then travelled aft. A juddering movement as the crane moved or came to an abrupt halt, combined with the forward leaning spreader, then triggered the port side of the hatch-lid to come free from the hooks.

The lid then pivoted momentarily about the starboard hooks before coming free and crashing into the starboard legs of the crane. This asymmetric loading followed by the impact of the 11t lid was sufficient to knock the crane off its rails. The fatigued bolts were not strong enough to keep the wheels secured to the gantry and gave way either as the crane derailed or as a result of impact at the end of its fall **(Figure 16)**.

It is remarkable that all three of the crew escaped with only minor injuries. If the chief officer had not fallen cleanly into the gap between the ship and the quayside, if the AB had not been able to hold on by his hands as he hung over the hold, or if the crane had not remained upright when it derailed, this accident could have resulted in up to three fatalities.

2.4 CRANE OPERATION, INSTRUCTIONS, DESIGN AND MANUFACTURE

2.4.1 Operation

The type of gantry crane fitted to *Blue Note* had been installed on a total of 42 vessels. Its manufacturer, Mariner Ship's Equipment, was not aware of any similar accidents occurring on other vessels. However, MAIB inspectors, who visited *Blue Note* and her sister vessel *Blue Carmel*, identified a number of common issues relating to the condition and operation of the vessels' gantry cranes:

- The lifting hooks were shorter than the design specification provided by the manufacturer.
- The cranes' spreader bars were not rigged to lay parallel with the suspended hatch-lid.
- There was little indication provided to the crane operators to verify that the lifting hooks were correctly located within the sockets on the hatch-lids.
- The crew on both vessels adopted the practice of riding on the gantry wheel units during lifting operations.
- There were no safe means of access provided that would allow the crew to closely observe whether the lifting hooks were correctly engaged in the sockets on the hatch-lids.

Three men operated the crane on both ships. However, Mariner Ship's Equipment's instructions stated that the crane could be operated with two men: one at the control platform and one on the coaming area of the deck. The instructions were not clear as to how one person would be able to check that the lifting hooks were engaged on both sides of the hatch-lid safely (without walking across the hatch-lid) or efficiently (without having to walk around the perimeter of the hatch to get to the other side).

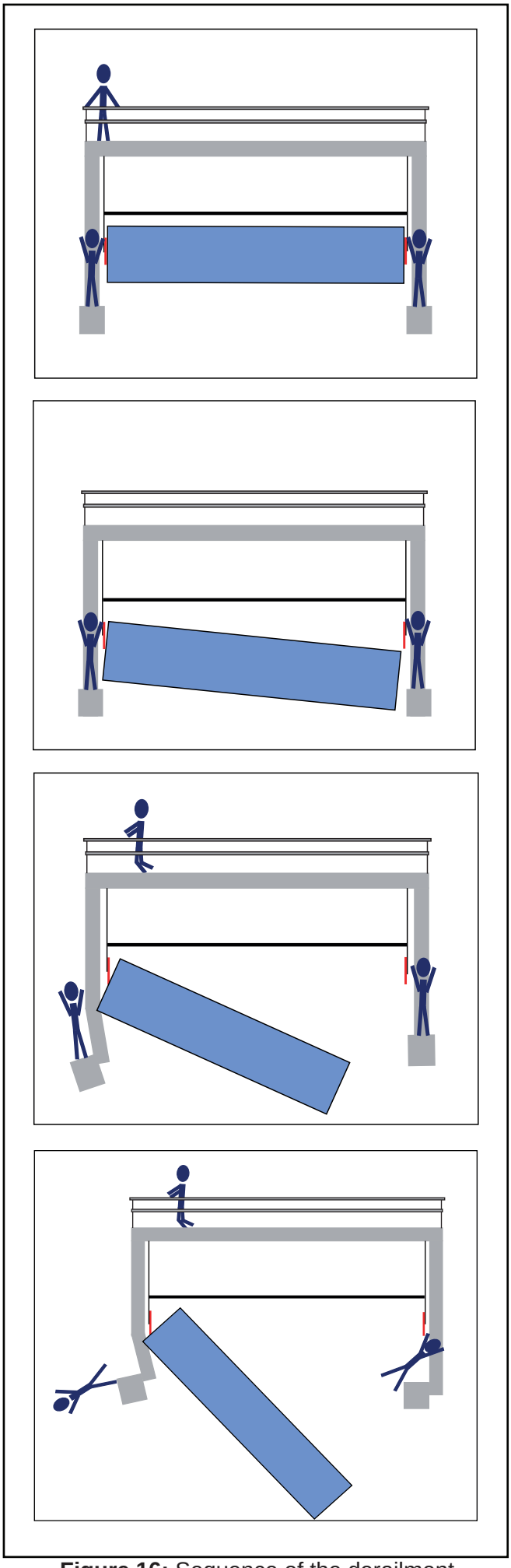

Figure 16: Sequence of the derailment

While the general method of operating the crane was clear from its design and construction, there were several critical aspects that had not been thought out so well. It was extremely difficult to see the position of the lifting hooks from the safety of the main deck due to the height of the hatch coaming. Consequently, it was inevitable that the operators would find other ways of completing the task.

Avoidable risks were introduced by the use of poor operating methods and not identifying potential defects with the crane. The operations manual was not available on board, however even if it had been, the crew would have found that the operating instructions did not describe in enough detail how to use the crane safely. Permanent etched diagrams and warning notices fixed at the control station and at deck level could also be added to highlight the hazards that crew might be exposed to and encourage them to use safer working practices.

2.4.2 Maintenance

The maintenance instructions within the operating manual were clear and covered the majority of tasks. However, they did not include instructions relating to adjustment of the spreader bar to keep it parallel to the hatch-lids, and consequently there was no written guidance which detailed the importance of securing the bottle screws with their locking nuts following any adjustment of the wires. While this is important, it is less of an issue in this accident; the manual was not on board at the time and the manufacturer's maintenance procedures were not being followed. However, although securing a locking nut may be a basic task, an instruction or maintenance checklist might prompt a seafarer to check that the crane is in a safe working condition following adjustment.

Both ILO152 and national regulations derived from European Directives for other lifting equipment require that equipment is inspected and re-tested after major repairs or alterations – such as the replacement of the lifting wire a few weeks before the accident. Although this is in contrast to the

arrangements for lifesaving appliances (davit fall wires etc), the gantry crane on *Blue Note* should have been re-tested before being put back into service. Such a test should also have included a thorough examination of the crane which would have identified that the bottle screws had not been locked and some wheel unit securing bolts were not tight enough.

2.4.3 Design

The design of the crane did not lend itself to safe operation. The hand-rails that were fitted above the wheels gave the false impression that it was acceptable for crew to ride on the wheel units as the crane moved, and added to the opportunity to do so. Furthermore, the crew had no other facility that gave them a safe position from which they could check that the lifting hooks were properly engaged. Therefore, they were obliged to make this judgment by looking at the hooks from a distance and with the hooks in varying conditions of light and shadow.

Even when a crew member was standing on a wheel unit and leaning out, it was not readily apparent when the short, unpainted hooks were fully engaged in the sockets **(Figure 17)**. It was even more difficult to confirm that the hooks were engaged if the lifting sockets were in shadow during bright sunlit conditions **(Figure 18)**. In the absence of a positive means of indication, as a minimum aid, the ends of the hooks should be painted in a contrasting colour to show when they are properly engaged. This should be done as part of the commissioning process during installation, and retrospectively to all other units already in service.

2.4.4 Manufacture

The length of the ends of the crane hooks on *Blue Note* was less than that shown on the original drawings and significantly less than a representative hook that was provided by the manufacturer to MAIB inspectors during the investigation. While some erosion of the hook ends could be attributed to wear and tear in operation, with 360 hours on the counter and the material confirmed to be of a suitable specification for use, it is probable that they had not been cut to the intended dimensions during manufacture.

Mariner Ship's Equipment could not confirm how the hooks for *Blue Note*'s crane were cut, but has confirmed that with its current computer-controlled cutting process, deviation from the design specifications could not occur in the future.

2.5 SAFETY MANAGEMENT SYSTEM

2.5.1 Previous audits

The issues of incomplete risk assessments and poorly planned and recorded maintenance on board *Blue Note* had been identified by the GL external audits but not in the internal audit that was conducted by the ISM consultant 'Guideline GmbH'.

Despite these non-conformities being raised by GL and the ship only ever being issued with short term Safety Management Certificates, neither Reederei-Meyering GmbH nor its ISM consultant appeared to correct the issues. Shortcomings in maintenance and risk assessments were fundamental failings and should have been

Figure 17: Visibility of engaged/disengaged hooks (*Blue Carmel*)

Figure 18: Aft hook in shadow (*Blue Carmel*)

identified and corrected as a priority. Although GL only issued short term Safety Management Certificates, greater emphasis was needed to ensure that Reederei-Meyering GmbH complied with both the requirements and intent of the ISM Code.

2.5.2 Training

While it may be an acceptable practice to rely on ships staff to informally instruct new joiners on how to use rudimentary cranes, operating the gantry crane was one of the most hazardous tasks on *Blue Note.* Informal instruction ran the risk of reinforcing bad practices, passing on poor procedures or missing key safety points. A formalised training programme or competence check is required to make sure that crew members can operate the crane correctly and safely.

2.5.3 Planned and recorded maintenance

Blue Note's crew had neither a planned programme of maintenance for the crane, nor the manufacturer's maintenance instructions to which they could refer when repairing defects.

While it might have been reasonable to expect the deck crew to carry out routine greasing and wire inspections without written guidance, other items such as checking and tightening the bolts every 2 months were unlikely to have been done without specific instructions. There is evidence of this from the fatigue cracking found in the bolts that secured the wheels to the gantry legs, which potentially increased the chances of the crane derailing once the hatch-lid had fallen from the hooks.

Even if a diligent and experienced crew member had maintained the crane in accordance with the manufacturer's instructions, with no written record it was impossible to track the history of the crane or to have any confidence in its ability to be used safely. The lack of maintenance instructions and history contravenes both the ISM Code and many of the commonly applied lifting regulations. Although these shortcomings were identified during the follow-up visit to *Blue Note,* no enforcement action was taken as a result of the subsequent Port State Control Inspection in Londonderry, as action against foreign-flagged vessels in the UK is only taken in the most serious cases.

2.5.4 Risk assessments

Risk assessments should be used to quantify the potential for seafarers being exposed to harm so that control measures can be put in place to minimise the hazards associated with a particular task. Without a risk assessment being undertaken before a task is carried out, the chances of all the hazards being identified and controlled are negligible.

Not wearing a safety harness while riding on the wheel units and leaning out to check that the hooks were engaged, both exposed the crew to serious injury or death following a fall from height. If they fell inboard they could face a drop of more than 8m into the hold **(Figure 19)** or be crushed between the moving gantry and the stack of hatch-lids. If they fell outboard, they could land on the quayside or in the water **(Figure 20)**, the latter exposing them to the additional risk of drowning.

A proper risk assessment of the crane operations should have prompted the crew to use safer working methods. However, if riding on the wheel units is deemed essential, then a properly considered, safe method should be provided.

The lack of any risk assessments, not only for the crane, but also any other operation on board, reflects poorly on the company's attitude to safety, the effectiveness of the internal audits, and its level of compliance with the ISM Code. Had a risk assessment been carried out for the removal of hatch-lids, it is likely that many of the poor practices such as riding on the crane's wheel units without a safety harness, or design flaws such as the inability to clearly confirm that the lifting hooks were engaged, would have been addressed.

Figure 19: Risk of falling into the hold (*Blue Carmel*)

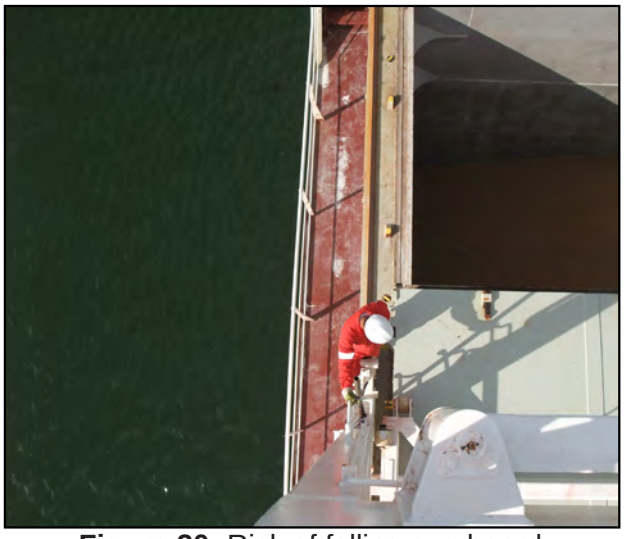

Figure 20: Risk of falling overboard (*Blue Carmel*)

2.6 SIMILAR ACCIDENTS

The MAIB's investigation into the failure of the stores crane on the dredger, *Sand Falcon*[3], concluded that weak inspection and maintenance regimes were common factors in many accidents involving lifting equipment. A safety flyer **(Annex G)** that was published following this accident, and another concerning the lifting vessel *Cormorant*[4], advised all operators to focus on effective maintenance, inspections and risk assessments to prevent similar accidents.

[3] www.maib.gov.uk/publications/investigation_reports/2010/sand_falcon

[4] www.maib.gov.uk/publications/investigation_reports/2010/cormorant

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT WHICH HAVE RESULTED IN RECOMMENDATIONS

1. Many of the wheel securing bolts had evidence of fatigue stresses which were probably caused by flexing in the structure when the bolts slackened off and were not sufficiently re-tightened in accordance with the manufacturer's maintenance schedule. This would have increased the likelihood of the wheels detaching during the accident. [2.3.3]

2. It is considered most likely that the wheels detached as a result of the derailment and the subsequent impact, rather than being the direct cause of the derailment. [2.3.3]

3. Several construction and operational factors increased the likelihood of the lifting hooks either not engaging in the lifting sockets correctly, or being able to disengage during the lifting operation. [2.3.4]

4. It is unlikely that the lifting spreader was parallel to the crane gantry; this would have caused uneven loading of the lifting hooks and contributed to the hatch-lid disengaging from the lifting hooks. [2.3.4]

5. The most likely cause of the accident was considered to be that the lifting hooks disengaged from the port side of the hatch-lid, allowing it to fall as the gantry was traversing aft to stow the hatch-lid. The subsequent uneven loading on the gantry caused the wheels to derail. [2.3.5]

6. As a minimum, lifting hooks should be painted in contrasting colours to indicate when they have properly engaged in the hatch-lid sockets. [2.4.3]

7. The length of the ends of the lifting hooks on both *Blue Note* and *Blue Carmel* was less than that shown on the manufacturing drawings and less than similar hooks that were provided by the manufacturers during the investigation. The reason for this difference could not be explained, but is unlikely to recur due to the manufacturing processes that are now used. [2.4.4]

8. A formal training programme is required to provide the crew with a full understanding of how the crane functions and ensure that they are competent to operate it safely. [2.5.2]

3.2 OTHER SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION ALSO LEADING TO RECOMMENDATIONS

1. Critical aspects of the crane's operation, such as the need to check that the lifting hooks were properly engaged, had not been thought out well enough in the design, construction or operating instructions. [2.4.1]

2. The maintenance instructions had not been followed and the crane had not been inspected, thoroughly examined or retested, as required by all of the major regulations for lifting equipment, after the lifting wire was changed. [2.4.2]

3. The design of the crane did not encourage the crew to use safe operating methods. [2.4.3]

4. With no formal maintenance programme or written records it was impossible to track the history of the crane, or have any confidence in its ability to be used safely. This contravened both the ISM Code and all of the commonly applied lifting regulations. [2.5.3]

5. The lack of risk assessments for not only the use of the crane, but also any other operation on board reflects poorly on the company's attitude to safety and its level of compliance with the ISM Code. [2.5.4]

SECTION 4 - ACTION TAKEN

4.1 ACTIONS TAKEN BY OTHER ORGANISATIONS

Mariner Ship's Equipment has:

- Revised its gantry crane design to include welded and painted marks to indicate when the hooks are in the correct position to engage the lifting sockets **(Annex I)**.

- Revised its gantry crane operating manual to include instructions relating to the adjustment of the four wires that suspend the spreader **(Annex I)**.

- Provided guidance to all existing and new operators of Mariner gantry cranes to: clarify how many people are required to operate the crane safely; specify where the operators should be positioned; and what indicators should be used to determine that the lifting hooks are properly engaged **(Annex I)**.

SECTION 5 - RECOMMENDATIONS

Reederei-Meyering GmbH is recommended to:

2012/107 Ensure that crews on its vessels comply with the intent of the International Safety Management Code and applicable national and international lifting equipment regulations by:

- The establishment of formal, written risk assessments of shipboard activities.
- The provision of equipment planned maintenance schedules and systems for recording maintenance of repairs.
- Ensuring that all relevant manufacturer's manuals for operating and maintaining equipment are provided on board its vessels.
- The introduction of a requirement for specific training and a competence check for those crew members involved in the operation of gantry cranes to fulfil the requirement for familiarisation training.

Mariner Ship's Equipment is recommended to:

2012/108 Revise its gantry crane design to:

- Provide a facility for the crew to safely and efficiently check that the hooks are fully engaged into the hatch-lid's side sockets.
- Notwithstanding actions already taken, provide clear indication when the hooks are not engaged to warn operators not to carry on lifting (such as by painting the ends of the hooks in a highly visible colour, or by other means).

Marine Accident Investigation Branch
March 2012

Marine Accident Report