Report on the investigation of

a lifting equipment failure

on board the floating sheerleg

Cormorant

102 berth, Southampton

7 March 2010

Marine Accident Investigation Branch
Mountbatten House
Grosvenor Square
Southampton
United Kingdom
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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, ACRONYMS AND TERMS

AB	-	Able bodied seaman
EU	-	European Union
GL	-	Germanischer Lloyd
gt	-	gross tonnage
IACS	-	International Association of Classification Societies
ILO	-	International Labour Organization
ISM	-	International Safety Management
kg	-	kilogram
kN	-	kilonewtons
kts	-	knots
kW	-	kilowatt
LOLER	-	Lifting Operations and Lifting Equipment Regulations
m	-	metre
MAIIF	-	Marine Accident Investigators' International Forum
PUWER	-	Provision and Use of Work Equipment Regulations
RO	-	Recognised Organisation
RS	-	Register of Shipping
SHEQ	-	Safety, Health, Environment, and Quality
SI	-	Statutory Instrument
SMC	-	Safety Management Certificate
SWL	-	Safe Working Load
t	-	tonnes

Floating sheerleg — A lifting appliance, not capable of turning, mounted on a floating body to enable the lifting appliance to be transported by water.

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

Cormorant

SYNOPSIS

At 1001 on 7 March 2010, the 85t 'A' frame on board the Netherlands registered floating sheerleg *Cormorant* collapsed on to the deck while being lifted into position. Substantial damage was caused to the wheelhouse, the 'A' frame and its supporting frames, and to deck fittings. Although there were three people in the wheelhouse and two on deck, there were no injuries.

The MAIB investigation has identified a number of factors which contributed to the accident, including:

- A deck fitting was overloaded by the unco-ordinated use of winches.
- The lifting operation was interrupted and the master's concentration was broken by the arrival of the vessel's commercial agent.
- The lifting operation had not been identified as a key shipboard operation. Consequently, no risk assessment had been carried out and there were no written procedures provided.

This was the third accident within 6 months investigated by the MAIB which involved the failure of a 'non-cargo' lifting appliance. A safety flyer has been issued to the shipping industry to highlight the importance of the identification of key shipboard operations and the maintenance and testing of all lifting appliances.

Recommendations have been made to the vessel's manager, Multraship B.V., and the Netherlands Transport and Water Management Inspectorate aimed at improving the safe operation of the company's vessels and ensuring that lifting appliances are treated in accordance with Netherlands regulation.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *CORMORANT* AND ACCIDENT

Vessel details

Registered owner	:	Multra Power Lift B.V.
Manager	:	Multraship B.V.
Port of registry	:	Terneuzen
Flag	:	Netherlands
Type	:	Self-propelled floating sheerleg crane
Built	:	1973 Hamburg, Germany
IMO number	:	7328073
Classification society	:	Germanischer Lloyd
Construction	:	Steel, ice strengthened
Length overall	:	54.08m
Gross tonnage	:	1505t
Engine power and type	:	4 x 119kW Schottel propellers
Service speed	:	6.8kts
Other relevant info	:	71kW bow thruster

Accident details

Time and date	:	1001 on 7 March 2010
Location of incident	:	102 berth, Southampton
Persons on board	:	5
Injuries/fatalities	:	None
Damage	:	Significant damage to the 'A' frame, supporting structure, deck equipment, and the wheelhouse.

1.2 NARRATIVE

Following 3 months awaiting orders in Lisbon, Portugal, the floating sheerleg *Cormorant* was taken under tow by the tug *Multratug 7* on 19 February 2010 for passage to the Netherlands. The following day, weather conditions deteriorated and the vessels sheltered in Fiqueira da Foz, until 1 March.

The subsequent passage across the Bay of Biscay and the south west approaches to the English Channel was uneventful, with *Cormorant*'s master and mate sharing the watchkeeping duties in the wheelhouse, which was manned throughout.

On 6 March, the tow was ordered to divert to Southampton for salvage operations. At 2200, the mate relieved the master in the wheelhouse 2 hours earlier than normal to allow the master the opportunity to rest before the vessel's arrival at about 0400 the following morning. The master returned to the wheelhouse at 0300 and, at 0445, *Cormorant* secured starboard side-to alongside 102 berth in Southampton **(Figure 1)** with *Multratug 7* secured outboard. The crews of both vessels then retired to their cabins.

At 0830, *Cormorant*'s master and four crew gathered in the mess room. The master briefed the crew that the morning's work was to rig the sheerleg, discharge the grab and a container to the quayside, and to then load two containers.

At approximately 0915, the engineer opened the ventilators on the aft deck and started two generators. Meanwhile, the master removed two chain lashings securing the head of the 'A' frame[1] to its stowage. He then checked that the two fixed back stays were clear and could be lifted from the deck. The master then went to the wheelhouse.

At approximately 0920, the master turned on the power to the two hoist winches and heaved on speed three, the fastest of its three speed settings. Two load meters in the wheelhouse showed a load of 110 tonnes on each of the two lifting blocks. The master monitored that all wires were running clear and that the 'A' frame was rising safely. The mate was on the port side of the main deck adjacent to the wheelhouse, keeping a visual watch on deck. The engineer was on the port side of the main deck by the door to the accommodation.

At 0942, *Cormorant*'s commercial agent arrived alongside the vessel in his car. Shortly afterwards, the master started the luffing winch[2] and payed out the wire. The hoist winches continued to heave and at 0950, the back stay wires tensioned and the luffing frame started to lift from its stowage. The speed of the hoist winch was reduced from setting three to setting two; the luffing winch was paying out the luffing wires on setting three, its fastest setting.

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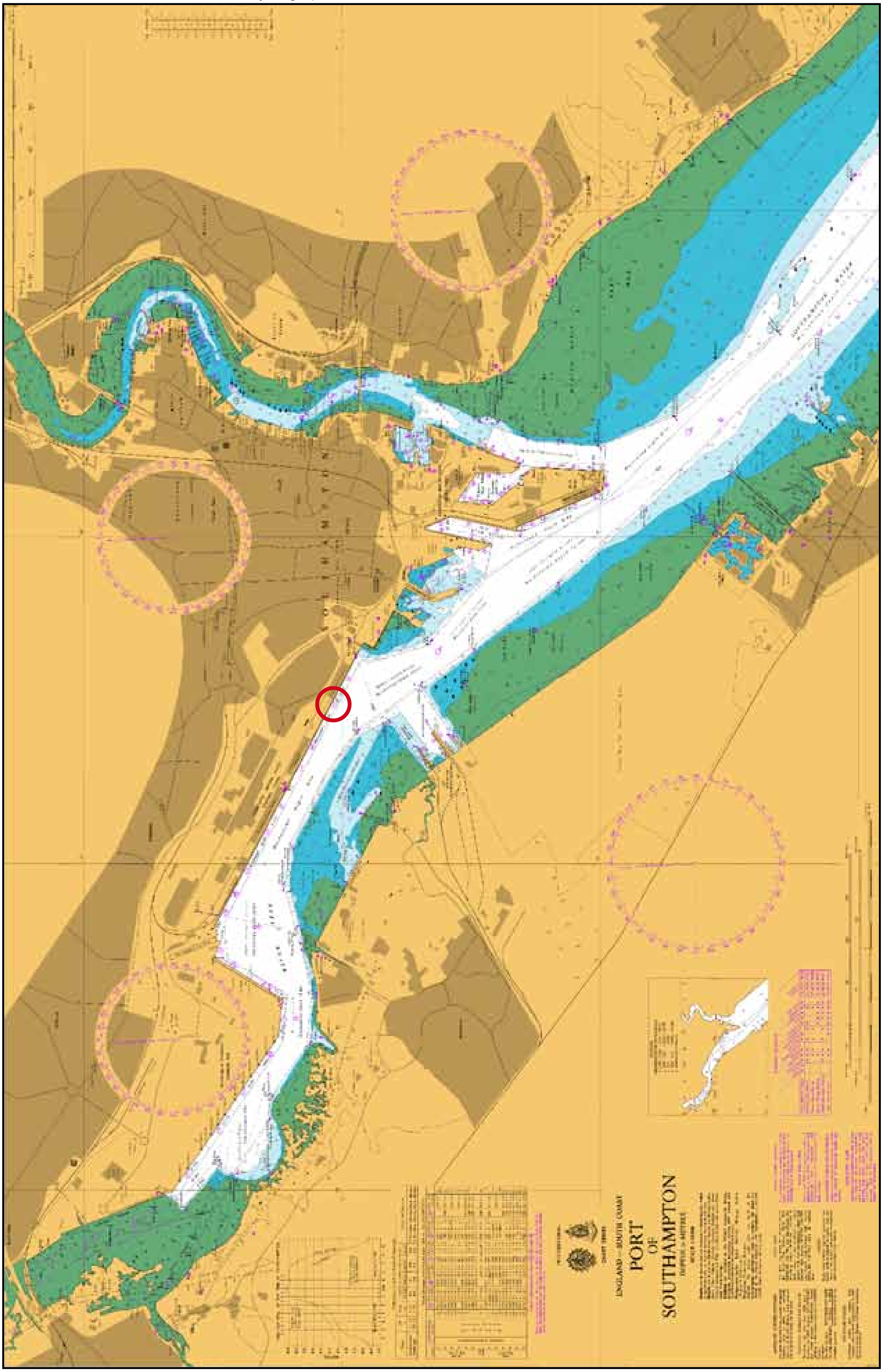
[1] 'A' frame - A term sometimes used to describe a crane jib. It is also referred to as a sheerleg.

[2] Luffing winch - A winch used to move the jib of a crane or raise or lower the boom of a derrick to shift a load.

Reproduced from Admiralty Chart BA 2041 by permission of the Controller of HMSO and the UK Hydrographic Office

Figure 1



Berth 102, Southampton

At 0956, the commercial agent boarded the vessel **(Figure 2)**. The master directed him to enter the wheelhouse using the port aft door, where he was met by the able bodied seaman (AB) who had come up from the accommodation to assist.

When the agent arrived in the wheelhouse, the master stopped the hoist and luffing winches and gave the required paperwork to the agent. At about 0958 the master re-started the lifting operation. Facing forward, he set the port and starboard hoist winches to heave on their slowest setting. He then turned and faced aft and moved the luffing winch control handle in order to slack back on its fastest setting. There was slack wire in the luffing purchase and the 'A' frame had passed through the vertical to a position where its head was about 2m to 3m forward of the bow. The master saw that the load meter reading was between 30 and 40t. This was the last occasion he looked at the load meters.

The agent remained in the aft part of the wheelhouse and inspected the ship's papers. The AB also remained in the wheelhouse to assist the agent.

At 1001, just as the hoisting and preventer wires were about to come into line, the port and then the starboard pad eyes holding the forward preventers broke away from the deck and were catapulted about 20m into the air **(Figure 3)**. Seconds later, the 'A' frame pivoted forward slightly before it, and the preventer and luffing frames, fell backwards onto the main deck **(Figure 4)**. As the frames fell, the mate took cover under a winch, the engineer stepped into the accommodation, and the master shouted to the AB and the agent to take cover. There were no injuries.

1.3 POST-ACCIDENT SURVEY AND INVESTIGATION

1.3.1 Survey of damage

The damage included:

- Fracture of the steel plates forming the pad eyes fitted to the deck.
- Buckling of the 'A' frame and its foundation **(Figure 5)**.
- Buckling of the preventer and luffing lifting frames.
- Impact damage to the forward section and deck head of the wheelhouse caused by the 'A' frame cross-member **(Figure 6)**.
- Impact damage to winch supply drums, wires and lifting blocks.

Stills footage from CCTV,
courtesy of ABP Southampton

Figure 2

Agent boarding the vessel

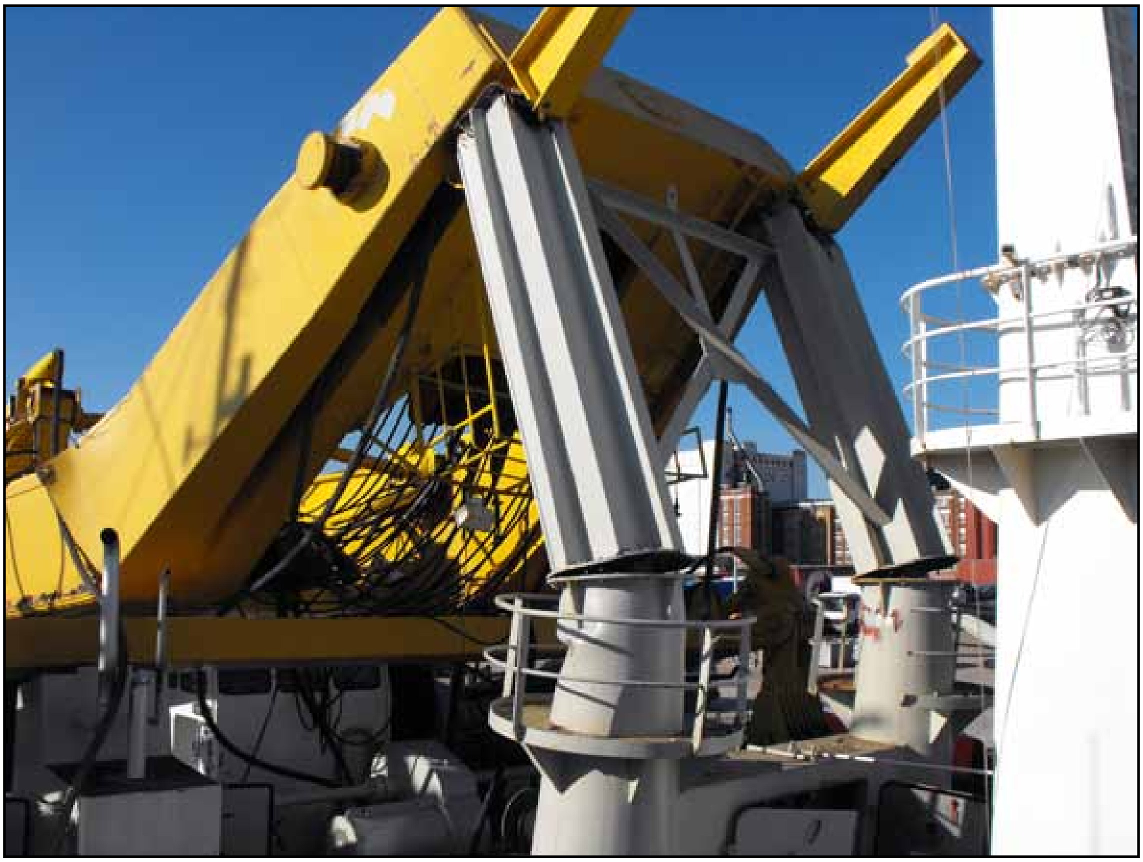
Figure 3

Failure of the port preventer deck pad eye

Figure 4

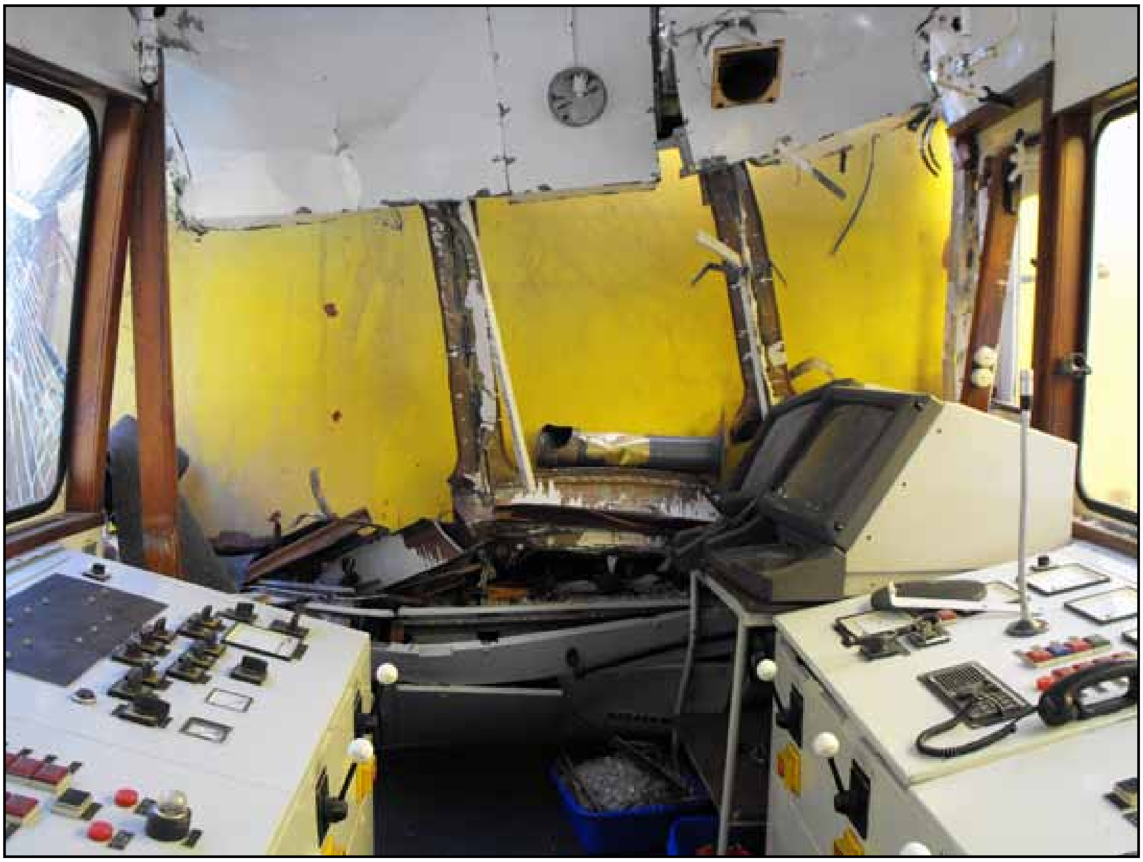
'A' frame falling on to the deck and wheelhouse

Figure 5



Buckling to the 'A' frame and its foundation

Figure 6



Wheelhouse damage

1.3.2 Metallurgical examination

The sections of the port and starboard pad eye that remained on the deck and on the preventer wire were removed from the vessel and were sent to the Test House, Cambridge for metallurgical examination. Observations of the examination included:

- Clear fracture origins were apparent at the plate fracture sites consistent with a single generally low ductility overload event.
- On the port plate one fracture comprised largely shear which in contrast to the other three fractures was exclusively ductile in nature.
- The steel plate adjacent to all fracture sites had undergone extensive yielding.
- All of the fillet welds retaining the ring had sheared through the throats, exposing some worm-hole porosity.
- A conservative estimate of a single event fracture force required was 4,713kN, approximately 480t, or 240t simultaneously on each fitting.
- The corrosion wastage and welding defects identified during examination were not thought to be significant in the failure process.

The examination report **(Annex A)** concluded:

The two preventer pad eye plates had failed in a simultaneous single overload event, exposing no evidence of previous fatigue cracking. Though some evidence of light local corrosion wastage was apparent in both plates, the presence of prior corrosion wastage was not considered significant in the failure process. Similarly, the widespread evidence of welder attributable welding defects was also not considered significant…

The preventer pads appeared to have failed in response to a fracture force, which calculations suggest was an order of magnitude greater than the normal rigging load. Consequently, our opinion is the preventer pads had been designed with a suitable safety margin and that failure had resulted from an operation defect rather than a latent design, materials, or workmanship type defect.

1.4 THE VESSEL

1.4.1 Build and ownership

Cormorant (ex *Sudopodjom 2*) was one of a series of 19 similar sheerleg cranes built by Howaldtswerke Deutsche Werft in Germany during the early 1970s. She was one of two Russian owned floating sheerleg cranes which were initially classed with the Russian Maritime Register of Shipping (RS), but were constructed to Germanischer Lloyd (GL) rules and their build was overseen by GL.

After conducting salvage operations in the Black Sea for many years, *Cormorant* was bought by Multraship in 1999 and was immediately surveyed and overhauled in Bulgaria. The vessel was transferred to the Netherlands Register and her classification society was changed to GL. Since her change of ownership, *Cormorant* had operated mainly in the Black Sea and Mediterranean.

1.4.2 Certification

Cormorant's certificate of seaworthiness restricted her operation to trading area 2, which is defined as:

> *Coastal waters whereby the distance to the nearest port and the offshore distance does not exceed 200 nautical miles.*

The vessel's safe manning certificate required a minimum of 4 persons on board: a master, an officer in charge of an engineering watch, and two deck ratings. The certificate only applied when *Cormorant* was operating under her own propulsion, and was therefore limited to:

> *Coastal waters whereby the offshore distance does not exceed 15 nautical miles and the sailing time from the port of operation, mentioned on the safe manning certificate, shall be within 12 hours and shall not be more than 6 hours from a port of refuge.*

The nominated safe port specified on the certificate was Vlissingen and that the crew were to be relieved after a period of 12 continuous hours.

1.4.3 The master

The master had worked in the towing and salvage industry throughout his seagoing career. He had been employed by Multraship for the last 10 years and was one of the company's most experienced masters. He worked a 2 months on, 2 months off cycle on board *Cormorant* and had raised the vessel's sheerleg numerous times, the last occasion being in June 2009.

The master held a Certificate of Competency for ships of less than 3000gt and for supply vessels and tugs of 3000gt or more in a limited trading area of 200 miles from a known port of operation.

Since leaving Fiquerira da Foz, the master had worked a 6 hours on, 6 hours off watchkeeping cycle in the wheelhouse. The hours of work and rest for the master and the crew had not been recorded since 2008.

1.5 LIFTING EQUIPMENT

1.5.1 Design

A side elevation of the crane showing its key components is shown at **Figure 7**. The specification of each component is detailed in **Table 1**.

No	Component	Specification
1	Main 'A' frame (85t)	SWL 400t
2	Preventer frame	N/A
3	Luffing frame	N/A
4	Forward preventer	(a) 500.7t (b) 1
5	Main stay	(a) 500t (b) 2
6	Strop for connection between lifting block and top of preventer frame	(a) 240t (b) 2
7	Main hoist wire	(a) 100t (b) 12
8	Luffing wire	(a) 115.9t (b) 14
9	Hoisting winches (port and starboard)	Maximum rated pull 19t
10	Luffing winch	Maximum rated pull 19t per drum
11	Preventer securing pad eye	SWL 110t

Table 1 – Lifting equipment specification

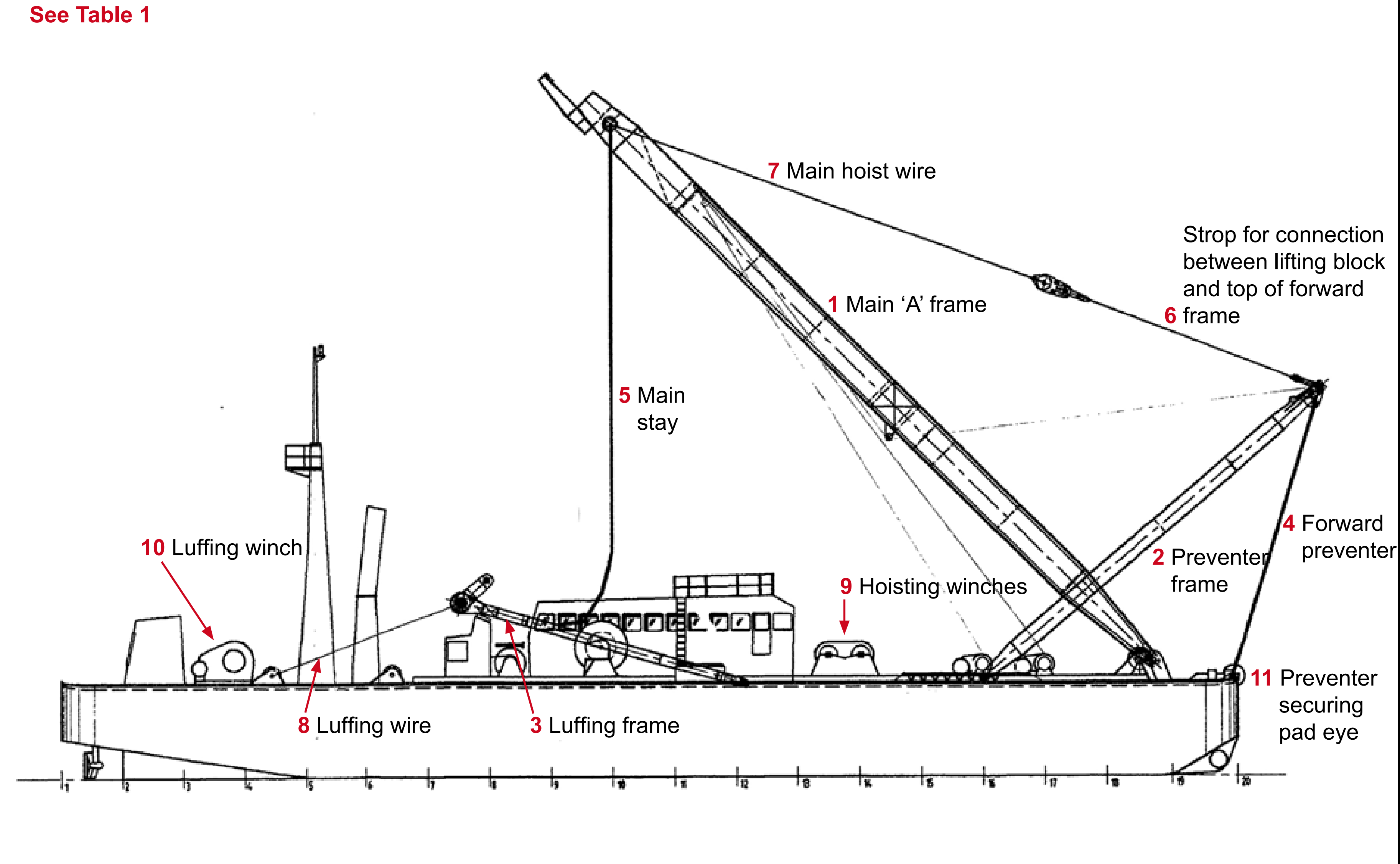
(a) Breaking load (b) Number of parts of wire

A drawing of a deck pad eye and associated under deck strengthening is shown in **Figure 8**. The pad eyes fitted on board *Cormorant* were designed with a Safe Working Load (SWL) of 110t and a breaking load of 220t. Both pad eyes were the originals from build; no known modifications had been undertaken and no maintenance, other than the application of protective coatings, had been conducted.

1.5.2 Seagoing condition

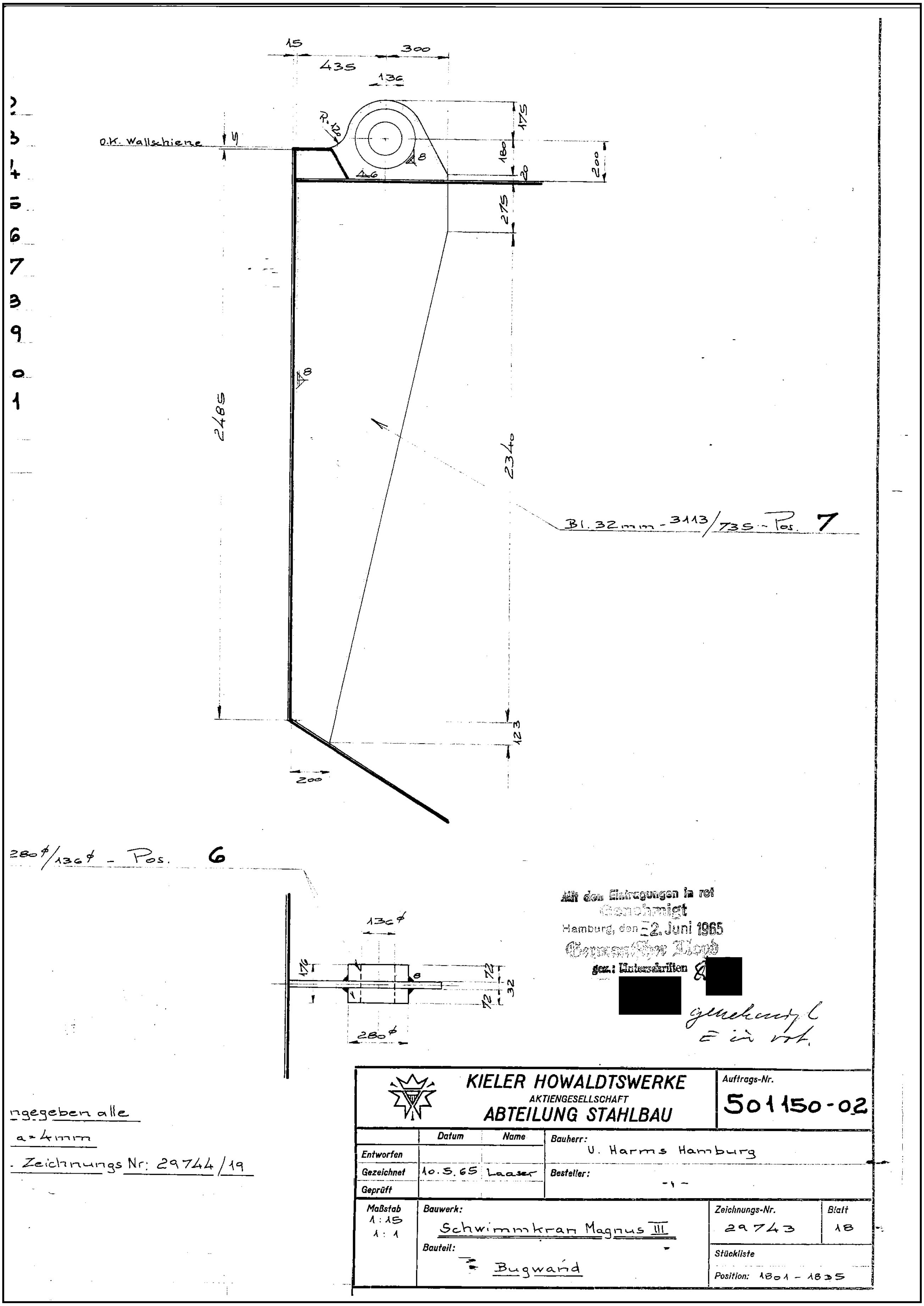
In the seagoing condition, the 'A' frame was stowed facing aft **(Figure 9)**. The head of the 'A' frame was secured on its foundation by two chain lashings. The port and starboard lower hoisting blocks were connected to a wire strop that was secured to the head of the preventer frame. The hoisting wire was hove taut, creating a load of approximately 30t on the head of the preventer frame. Part of the load was taken by the forward preventers which were secured to the head of the preventer frame and to the deck pad eyes. The load on the hoisting wires kept the lower blocks clear of the deck.

Figure 7



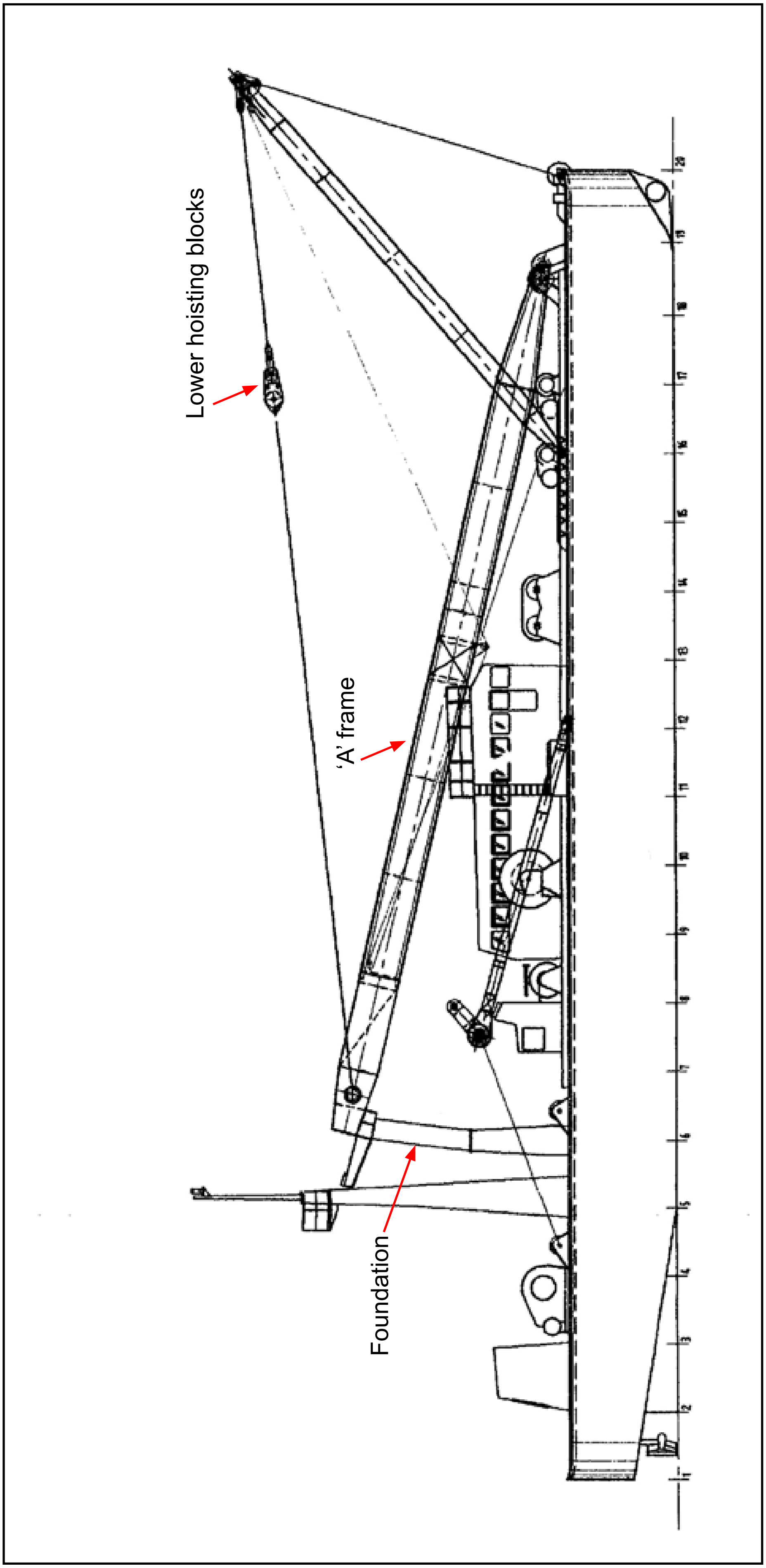
Lifting equipment arrangement

Figure 8



Design of pad eye and structure

Figure 9



'A' frame in its seagoing (stowed) condition

1.5.3 Winches

All of the winches and supply drums were visible from the wheelhouse. The port and starboard hoist wires were connected to separate winches. Both hoist winches were constructed in 1973 and approved by GL. Each had a maximum pull of 19t and was capable of exerting a load of 205t via a 12-fold lifting purchase (assuming a 10 percent reduction for friction). Each winch was fed automatically by a supply drum and was operated by a handle on the forward end of the winch control panel in the wheelhouse **(Figure 10)**. Both winches were fitted with load sensors that fed potentiometer displays adjacent to the winch control handles **(Figure 10 - inset)**. Similar sensors were fitted to the upper hoist blocks which fed digital meters suspended from the wheelhouse deck head forward.

Figure 10

Control for port hoist winch and luffing winch control

The port and starboard luffing wires were attached to separate drums, connected by a common drive shaft. The winch had a maximum pull of 19t on each side and was capable of exerting a load of 239t via a 14-fold purchase (allowing 10 percent reduction for friction). The winch was operated by a handle on the port side of the winch control panel in the wheelhouse **(Figure 10)**. There were no load sensors fitted to the luffing system.

The winch control handles operated in accordance with class rules. To slack back, the handle was moved forward; to heave, it was moved aft. Each winch control handle had three speed settings for heaving and slacking, and an emergency stop control was positioned under each handle. The winch control handles were designed to remain at the selected setting without the need for the operator to maintain a hold. When the luffing winch was operated, a white light flashed above its control handle.

1.6 RIGGING PROCEDURE

From the seagoing condition, the two chain lashings are removed from the head of the 'A' frame. The 'A' frame is then slowly lifted by heaving on the port and starboard hoist wires, with the weight being borne by the head of the preventer frame and the two forward preventers connected to the deck pad eyes.

As the 'A' frame is raised, the two fixed backstays also rise, but before they become taut, the luffing wires are slackened, which allows the 'A' frame to continue towards the vertical and the luffing frame to lift from its stowage.

Heaving on the hoist wire continues until the 'A' frame has passed through the vertical by about 2m to 3m. This is necessary to counter the weight of the backstays, the luffing frame, and the luffing wires acting at the head of the 'A' frame. As the 'A' frame continues to move forward and passes its natural tipping point, the load is transferred from the hoist wires to the luffing wires. Control of the movement of the 'A' frame is then achieved by slacking or heaving on the luffing wires.

The 'A' frame is then secured to the preventer frame with locking pins to form a single structure. The removal of pins located at the base of the preventer frame allows the frame to move fore and aft along a track way as the 'A' frame is subsequently luffed in or out. The forward preventers are then removed.

The time required for the winches to manoeuvre the 'A' frame from its stowage to the fully luffed position takes approximately 1 hour. A further hour is required to complete the rigging operation before the 'A' frame is ready to lift a load.

A technical procedure explaining the physical requirements for the lifting and rigging of the 'A' frame was provided in the rigging document held on board *Cormorant*.

1.7 LIFTING REGULATIONS

1.7.1 International Labour Organization (ILO) Convention 152

ILO 152 – Occupational Safety and Health (Dock Work) Convention, 1979 contains the measures to be taken in relation to the rigging and use of ships' derricks and the testing, examination, inspection and certification of lifting appliances, loose gear and other items forming an integral part of the load.

The term lifting appliance is defined as '*all stationary or mobile* ***cargo handling*** *appliances, including shore based power operated ramps, used on shore or onboard ship for suspending, raising or lowering loads or moving them from one position to another while suspended or supported*'.

It requires that a lifting appliance and loose gear be tested in accordance with national laws before being used for the first time, and lifting appliances forming part of a ship's equipment are re-tested at least once every 5 years. Additionally, the lifting appliance and loose gear should be periodically, thoroughly examined and certified by a competent person, at least once in every 12 months.

The Convention also requires that a register of lifting appliances and loose gear is maintained containing all certificates in respect of testing, thorough examination and inspection.

1.7.2 Netherlands regulation

The Netherlands administration has delegated the testing and thorough examination of lifting equipment and loose gear, as required by ILO 152, to seven recognised organisations (RO) (classification societies).

The European Union's (EU) minimum health and safety requirements for the use of work equipment by workers at work are contained in EU Directives 2009/104/EC and 89/391/EEC. Article 5 of directive 2009/104/EC requires the inspection of work equipment, including initial inspections, periodic inspections and testing by competent persons. Member States are required to determine the conditions under which such inspections are made. Annex I of the directive provides minimum requirements for work equipment when used for lifting loads, in particular the stress induced at the mounting or fixing point of the structures.

In the Netherlands, the directives were enacted through the Working Conditions Act 1999 and detailed regulation was implemented through the Working Conditions Decree. Articles 7.20 and 7.29 of the decree **(Annex B)** stipulate the requirements for lifting and hoisting gear and lifting and hoisting tools on board ships, and incorporate the requirements of ILO 152 as well as the European Directives.

The Netherlands administration has provided guidance on the certification of lifting appliances and loose gear **(Annex C)**, which separates the requirements for lifting appliances and loose gear used for cargo handling, from other lifting appliances and loose gear on board ships. For the latter, the guidance states:

> *Non-cargo handling lifting appliances and loose gear on board ships shall be administered according to the relevant regulations of the Working Conditions Decree (art 7.18, 7.18a and 7.20).*
>
> *It is up to the owner or master how to comply with the requirements. Any involvement of the RO is not under the Agreement between the Administration and the RO*

1.7.3 United Kingdom - LOLER

In the UK, the European Directives were implemented through the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER), and the Provision and Use of Work Equipment Regulations 1998 (PUWER). These regulations were subsequently implemented through Statutory Instrument 2006 / 2184 The Merchant Shipping and Fishing Vessels (Lifting operations and Lifting Equipment) Regulations 2006 (LOLER), which applies to all UK registered ships, and to other ships when they are in UK waters.

In LOLER, lifting equipment is defined as:

> ***Work equipment*** *used for lifting or lowering loads and includes its attachments used for anchoring, fixing or supporting it.*

The regulation requires that all lifting equipment should be tested by a competent person within the preceding 5 years, and thoroughly examined at least every 12 months.

1.7.4 Classification Society rules

During build, *Cormorant* was surveyed under the 1969 GL rules for the construction and survey of cargo-handling appliances. The 1969 rules did not require that lifting equipment was fitted with alarms, interlocks, or trips.

GL's rules were subsequently revised and republished as the 'Regulations for the Construction and Survey of Lifting Appliances 1992' which included specific requirements for sheerleg cranes, and defined the term lifting appliance as:

> *'comprises power-driven gear for lifting, transporting or conveying goods or raw materials'*

The 1992 rules recognised the use of safety devices such as limit switches when an operator was unable to oversee the full movement of an appliance; overload protection on hoisting and luffing winches to prevent a lifting appliance from exceeding its SWL by more than 10%; and warning devices controlled by the operator to alert personnel on deck.

1.8 TEST REGIME

Since 2000 all of the tests and thorough examinations of the lifting equipment on board *Cormorant* had been carried out by GL. Maintenance and replacement of loose gear had been carried out by the ship's crew and specialist shore contractors. *Cormorant*'s lifting register was issued by GL in September 2000 and was based on the standard form recommended in ILO 152. Entries in the register included:

- 'A' frame - 5 yearly test - 07 September 2005
- 'A' frame - annual thorough examination - 28 September 2009
- Interchangeable components - thorough examination - 07 January 2010.

At the 5 year load test, the 'A' frame was rigged by the crew and presented to a GL surveyor in a condition in which the crane was ready to lift a test weight. The rigging and striking of the crane was not considered to be part of the test procedure.

1.9 SAFETY MANAGEMENT

1.9.1 Audit

Multraship was issued with an initial International Safety Management (ISM) Document of Compliance by GL on behalf of the Netherlands administration on 6 July 2007. Annual verification inspections were conducted by GL in 2008 and 2009.

Cormorant's ISM Safety Management Certificate (SMC) was issued on 17 August 2007 after the vessel's safety management system was audited and found to be in accordance with the ISM Code, well implemented, and understood on board.

Cormorant is the only vessel in the Multraship fleet requiring ISM certification. The company's last internal audit on board the vessel was conducted on 19 November 2008 during which two observations were made, neither of which concerned the vessel's equipment or its operation.

1.9.2 Risk assessment

The Netherlands Working Decree article 5.3 requires that employers conduct a risk inventory and evaluate potential risks in the work place. Accordingly, in March 2003, Multraship engaged a consultant (Arbo Dienst) to carry out an inventory of the company, which included an evaluation on board *Cormorant*. The inventory focused on occupational risks in the work place such as trips, falls, noise, and handling lines. It did not consider the lifting and rigging of the 'A' frame, for which no risk assessment was undertaken.

1.10 PREVIOUS ACCIDENTS

The MAIB is not aware of any similar accidents involving sheerleg cranes. However, three recent MAIB investigations are relevant. The first concerned a hazardous incident that occurred during a diving operation on board the self-propelled crane barge *Norma*, in June 2008 (MAIB report 3/2009). The investigation identified that a lack of key shipboard operational procedures had been contributory, and the MAIB recommended the International Association of Classification Societies (IACS) to:

> *Highlight to its membership the need to identify key shipboard operations integral to a vessel's intended and potential employment and to ensure appropriate associated procedures have been developed whenever conducting ISM Code audits as recognised organisations on behalf of Flag States.*

The second investigation concerned the death in September 2009 of an AB who drowned as a result of the accommodation ladder he was rigging falling into the water following the failure of its hoist winch on board the container ship *Ever Elite* (MAIB report 8/2010). The winch was not considered to be lifting equipment and had not undergone thorough examination or a 5-yearly test. As a result, the MAIB recommended the Maritime and Coastguard Agency (MCA) to:

> *Take action to ensure that accommodation ladder hoisting systems on board UK registered vessels are maintained and records kept in accordance with the Lifting Operations and Lifting Equipment Regulations.*

The third investigation was into the detachment of a trolley from a gantry-type crane on board the UK registered dredger *Sand Falcon* in January 2010. The trolley weighed over 400kg and fell 7.5m on to deck guardrails, narrowly missing 7 people who were working nearby. The accident was one of 29 cases reported to the MAIB since 2001 involving the failure of non-cargo handling cranes. The investigation report (MAIB report 16/2010) concluded that the failure of the crane was due to a combination of design flaws, lack of maintenance, and weaknesses in the inspection and testing methods adopted.

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 POINT OF FAILURE

Metallurgical analysis of the pad eye fittings **(Annex A)** estimated that a load of 240t was required for each pad eye to fail in a simultaneous single event. Therefore, there is no doubt that the pad eye fittings, which were designed with an SWL of 110t, were significantly overloaded. There is no evidence to indicate that the failure of any of the machinery, wires, and other loose gear contributed to the accident.

As soon as the port pad eye failed, the full load was borne by the starboard fitting which failed 3 seconds later. A large reactive force then acted on the preventer, luffing, and 'A' frames, causing them to move backwards towards their deck stowages.

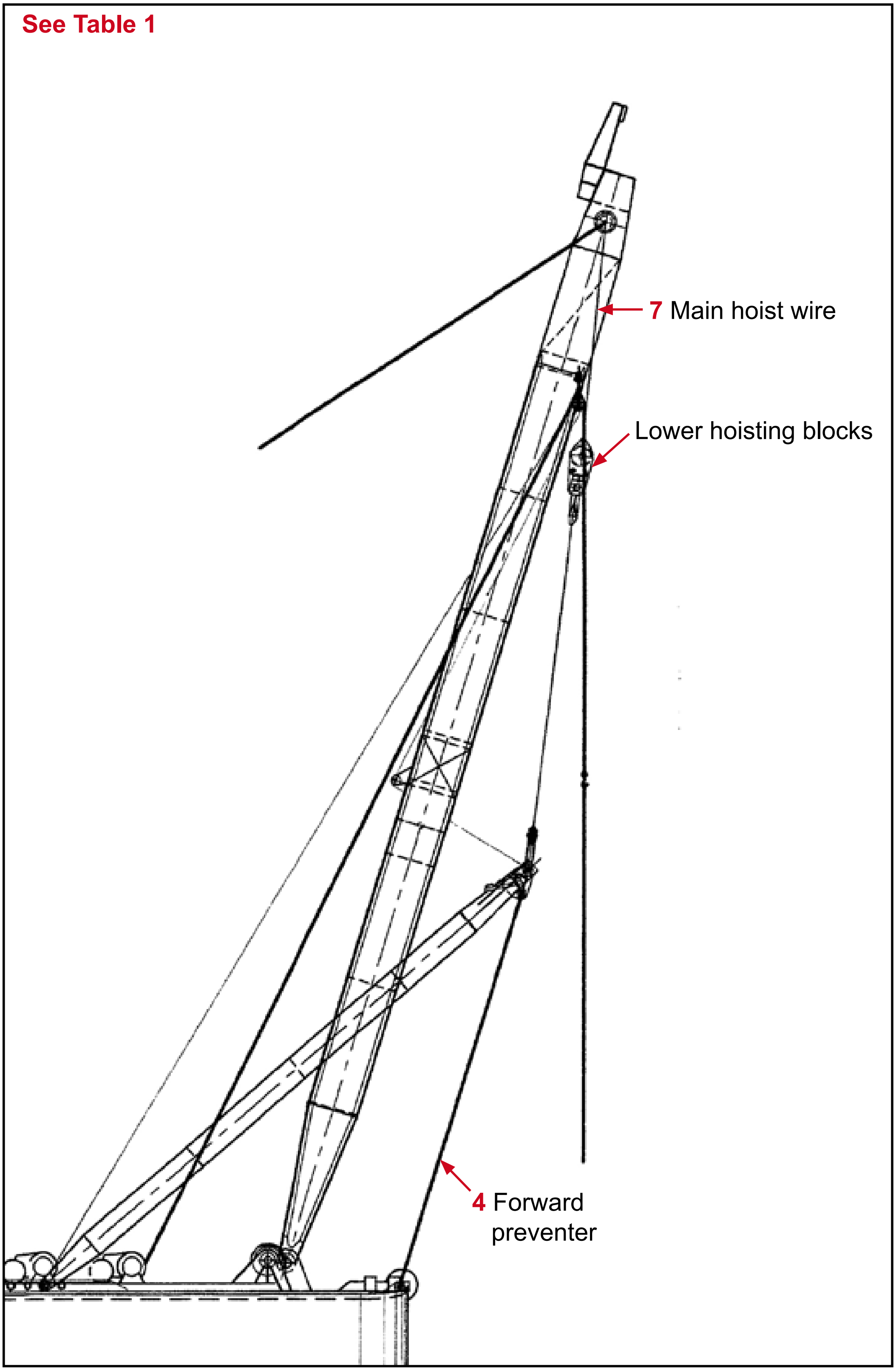
2.3 OVERLOADING

The accident occurred as the hoisting and preventer wires, components 7 and 4 on **Figure 11**, were about to come into line. This was a critical period, during which time the load imparted on the preventer by the hoist winches needed to be carefully balanced and monitored against the slack remaining in the luffing wires. It was also close to the time when the weight of the 'A' frame was transferred from the hoisting to the luffing wires. The only way that a load of 240t could have developed was through a lack of co-ordination in the use of the hoisting and luffing winches. Therefore, it is almost certain that although the hoist winch was heaving as intended, the luffing winch was either stopped or was also heaving.

When the rigging operation re-commenced, there was slack wire in the luffing purchase, and therefore the low load meter reading on the hoist wires observed by the master was expected. By heaving on the hoist winch, albeit at its slowest speed, a load was exerted on to the hoist and preventer wires which moved the 'A' frame forward. If the luffing winch remained stopped, the luffing wires would have tensioned and the load exerted by the hoisting winches would have been carried by the hoist and preventer wires to the pad eye fittings on the deck. Notwithstanding that each winch was capable of exerting a maximum pull of just over 220t, this was only 20t short of the estimated fracture force required.

Alternatively, it is equally likely that after putting the hoist winches to heave, the luffing winch was also set to heave rather than to slack back. Consequently, when all the slack in the luffing wire had been taken up, the hoist and luffing winches would have exerted a load in excess of 240t on the pad eyes.

Figure 11



Position of ‘A’ frame at its point of collapse

2.4 WINCH CONTROL

It is significant that the lack of co-ordination in the use of the winch controls occurred shortly after the rigging operation had been resumed following a pause of about 2 minutes while the master dealt with the ship's agent. Although the master had hoisted the 'A' frame and rigged the crane on many occasions, and the operation was relatively slow, this interruption was nevertheless a distraction for the master, which broke his concentration. Distractions of this nature can easily lead to human lapses and errors and, on this occasion, it possibly resulted in the master losing his place in the sequence of events. It is also possible that the master put the luffing winch to heave rather than to luff as a result of facing aft rather than forward when operating its control lever. Neither of these lapses would have been quickly evident due to the slack in the luffing wire at the time.

Although the master had kept alternate 6 hour watches during the passage from Portugal, the vessel had previously spent over a week in Fiqeira da Foz and the watchkeeping duties when under tow would not have been arduous. Therefore, fatigue resulting from a lack of sleep is not considered contributory to the master's performance. However, given *Cormorant*'s early arrival at Southampton, which necessitated a change to the master's sleep pattern to ensure his availability in confined waters, it is possible that his alertness was diminished to some degree during the rigging operation.

2.5 SAFETY BARRIERS

A key element to the safety of any work activity is the provision of robust barriers to prevent the actions of an individual resulting in an accident. Such barriers are usually identified by risk assessment. In this case, although Multraship had undertaken a risk inventory required by the Netherlands Working Conditions Decree, it had focused on occupational hazards. Examination of shipboard operations such as the rigging and striking of the crane and associated equipment, which were complex, potentially dangerous and critical to the vessel's operation, was not considered. As a result, the hazards inherent in these practices were not assessed, and several key barriers were not in place.

First, there were no written procedures regarding the precautions to be taken or the responsibilities and roles of individuals. As a result, the procedure followed was decided by the master, who opted to operate the winches himself. A practice adopted on a small number of other similar vessels is to use an AB to control the winches to the master's instructions. On this occasion, this would have allowed the master to properly monitor the load meter readings, watch the activities of the personnel on the deck, and to check the winch operator's actions. The master also permitted the ship's agent to board and, consequently, interrupt the operation. The prohibition of non-essential personnel from the deck during the operation would have prevented the master from becoming distracted.

Second, the rigging equipment on board *Cormorant* was not fitted with alarms or interlocks because none were required at the time of her build, and subsequent grandfather rights[3] exempted the vessel from complying with GL's revised rules which came into effect in 1992. Although four load meters were fitted, these required regular monitoring, whereas visual and audible overload alarms fitted on similar vessels **(Figure 12)** automatically warned the operator when 95% and 105% of the maximum permissible load was reached. Given the relatively slow speed of the rigging operation, had such an alarm been fitted it would have undoubtedly allowed the master to take action before the failure occurred. The use of electrical interlocks would also have physically prevented the pad eyes from being overloaded.

Finally, there were no signs or labels to show the directions of heave and slack by the winch controls. The master of *Cormorant* had many years of experience operating the crane, but such labelling provides a simple reference that might have prevented the luffing winch from inadvertently being operated in the wrong direction.

Figure 12

Overload warning and alarm display

3 A grandfather right refers to a legislative provision that permits an exception based on a pre-existing condition.

2.6 SAFETY MANAGEMENT

Traditionally, the salvage and towage sector of the marine industry has relied on the experience of its masters to ensure tasks are completed safely and efficiently. Consequently, masters in this sector are allowed a great deal of independence in the running of their vessels.

However, while this gives masters the flexibility to meet the challenging and sometimes unexpected demands of salvage operations, there is no justification for masters alone to decide how routine operations are conducted. Ship owners and managers in the salvage and towage sector must take responsibility to ensure that all key shipboard operations are identified, associated hazards are assessed, and that safe systems of work are implemented. They must also ensure that basic requirements such as the recording and monitoring of hours of work and rest, which was not undertaken on board *Cormorant*, are adhered to.

As the ISM Code requires that companies develop and implement '*instructions and procedures to ensure the safe operation of ships*', it is of concern that the absence of even basic onboard procedures for one of *Cormorant*'s regular key shipboard operations had not been identified during the vessel's internal and external audits. A similar situation was found following the diving incident that took place from the self-propelled salvage barge *Norma*, which resulted in MAIB's recommendation to IACS (Paragraph 1.10).

2.7 LIFTING EQUIPMENT AND REGULATION

The pad eyes and other equipment on board *Cormorant* used to raise the 'A' frame into position were not considered to be 'cargo lifting' appliances as defined by ILO 152. Furthermore, and importantly, the pad eyes had also not been identified as 'non-cargo handling' lifting appliances **(Annex B)**. Consequently, although 37 years old and used to raise a 85t sheerleg, the pad eyes were not subjected to the testing and condition monitoring requirements of either the international convention or national regulation **(Annex C)**; they were not included in the vessel's lifting register, they were not load tested, they had not undergone annual thorough examination, and their use in the rigging procedure had not been witnessed by attending surveyors.

There is currently no international regulation of non-cargo lifting appliances. European administrations have implemented the requirements of European Directives through national regulation such as the National Working Decree (Netherlands) and LOLER and PUWER (UK). However, it is evident that the differences between these requirements and the ILO requirements for 'cargo' lifting appliances has frequently resulted in 'non-cargo' lifting appliances either not being identified, or treated with lesser diligence. This is because European regulation places the onus for compliance solely with vessels' owners. Unlike the requirements of ILO 152, compliance with national regulations concerning non-cargo lifting appliances does not tend to be verified by the Flag states, classification societies, or by coastal states during port state control inspections.

In this case, the condition of the pad eye fittings was not contributory to the accident. However, corresponding deck fittings on board a similar vessel were subsequently subjected to non-destructive testing, and failed due to cracked welds. This finding, along with the failures to other non-cargo lifting appliances highlighted in paragraph 1.10 clearly demonstrates the need for owners to identify, record, examine and test all lifting appliances and loose gear on board their vessels, regardless of their use. In the longer term, a single, harmonised international regulation covering all lifting appliances used on board ships would be less confusing and easier to administer.

SECTION 3 - CONCLUSIONS

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

1. The collapse of the 'A' frame resulted from the vessel's deck pad eye fittings being significantly overloaded. [2.2]
2. The only way that a sufficient load could be exerted on the pad eyes to cause their failure was through a lack of co-ordination in the use of the hoisting and luffing winches. [2.3]
3. The arrival of the ship's agent broke the master's concentration and possibly resulted in him losing his place in the sequence of events. [2.4]
4. The hazards inherent in the rigging of the vessel's crane, one of the vessel's key operations, were not assessed. Consequently, several important safety barriers were not in place. [2.5]
5. There were no written procedures regarding the precautions to be taken or the responsibilities and roles of individuals during the raising of the 'A' frame. [2.5]
6. Although compliant with the applicable regulations, the rigging equipment on board *Cormorant* was not fitted with alarms or interlocks to warn or prevent elements of the equipment becoming overloaded. [2.5]
7. There were no signs or labels to show the directions of heave and slack by the winch controls, and it is possible the master inadvertently moved the luffing winch control in the wrong direction. [2.4, 2.5]
8. Ship owners and managers in the salvage and towage sector must take responsibility and ensure that all key shipboard operations are identified, the associated hazards are assessed and that safe systems of work are implemented. [2.6]
9. It is of concern that the absence of even basic onboard procedures for one of *Cormorant*'s regular key shipboard operations had not been identified during the vessel's internal and external audits. [2.6]

3.2 SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION WHICH HAVE NOT RESULTED IN RECOMMENDATIONS BUT HAVE BEEN ADDRESSED

1. Although the condition of the failed pad eyes on board *Cormorant* was not contributory to the accident, they had not been identified as lifting appliances, and therefore were not subjected to the testing and condition monitoring requirements of either ILO 152 or national regulation. [2.7]
2. It is essential that vessel owners identify, record, examine and test all lifting appliances and loose gear on board their vessels, regardless of their use. [2.7]
3. In the longer term, a single, harmonised international regulation covering all lifting appliances used on board ships would be less confusing and easier to administer [2.7]

SECTION 4 - ACTION TAKEN

4.1 MULTRASHIP B.V.

Multraship B.V has investigated the accident in accordance with its SHE-Q policy. The investigation report failed to reach any conclusions regarding the cause of the accident, but identified the following actions, which have either been implemented or are under consideration:

- To provide detailed risk assessments and written operational procedures for raising and lowering the A-frame.
- To provide a more detailed operations manual.
- To provide instructions for crews to complete hours of rest records.
- To restrict access to the vessel when critical operations are taking place.
- To identify safety devices that may be fitted on board *Cormorant* to increase safety during rigging operations.

4.2 THE MARINE ACCIDENT INVESTIGATION BRANCH

A brief description and safety lessons from this accident have been included in a safety flyer to the shipping industry **(Annex D)** highlighting recent accidents involving non-cargo handling lifting equipment.

The Chief Inspector of Marine Accidents has placed the issue of accidents involving non-cargo lifting appliances on the agenda for the next meeting of the Marine Accident Investigators' International Forum (MAIIF) in order to establish the incidence of similar accidents reported to other administrations, and to investigate the potential benefits of international regulation in this area.

SECTION 5 - RECOMMENDATIONS

Multraship B.V. is recommended to:

2010/132 Identify all key shipboard operations on board its vessels and ensure that safe systems of work are implemented through thorough risk assessments, the provision of written procedures and other identified control measures, and the examination and testing of all 'non-cargo' lifting appliances in accordance with national regulation.

The **Netherlands Transport and Water Management Inspectorate** is recommended to:

2010/133 Satisfy itself that Multraship B.V. has fully complied with MAIB recommendation 2010/132 and identified all key shipboard operations, applied safe systems of work, and is examining and testing all 'non-cargo' lifting appliances in accordance with Netherlands' regulations.

Marine Accident Investigation Branch
November 2010

Safety recommendations shall in no case create a presumption of blame or liability