Report on the investigations of

heavy weather damage

on board the container ship

Maersk Newport

50 miles west of Guernsey

on 10 November 2008

and fire

alongside at the container berth in Algeciras, Spain

on 15 November 2008

Marine Accident Investigation Branch
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Report No 13/2009
June 2009

In the investigation relating to the fire on board *Maersk Newport* on 15 November 2008, the MAIB has taken the lead pursuant to the International Maritime Organization Code for the Investigation of Marine Casualties and Incidents (Resolution A.849 (20) with the co-operation and assistance of the Spanish authorities (the Coastal State). The Coastal State's contribution to this investigation is acknowledged and gratefully appreciated

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

ABS	-	American Bureau of Shipping
AIS	-	Automatic Identification System
APA	-	Algeciras Port Authority
APM	-	A.P. Møller
BA	-	breathing apparatus
BOC	-	British Oxygen Corporation
CD-ROM	-	Compact Disc – Read Only Memory
DG	-	dangerous goods
DPA	-	Designated Person Ashore
ECR	-	Engine Control Room
EIGA	-	European Industrial Gases Association
GSMS	-	Global Ship Management System
HSSE	-	Health and Safety, Security and Environment
ISGOTT	-	International Safety Guide for Oil Tankers and Terminals
ISM Code	-	International Safety Management Code
kN	-	kilo Newton
m	-	metre
mm	-	millimetre
MMS	-	Maersk Marine Services
MSDS	-	Material Safety Data Sheet
N	-	Newton
OIC	-	Officer-in-charge
OOW	-	Officer of the watch
PTW	-	Permit to Work

SJA	-	Safe Job Analysis
SMS	-	Safety Management System
SOG	-	Speed over the ground
SOLAS	-	International Convention for the Safety of Life at Sea
SPOS	-	Ship's Performance Optimisation System
T	-	True
TTI	-	Tension Technology International
UMS	-	Unmanned Machinery Space
UTC	-	Universal Time Co-ordinated
VDR	-	Voyage Data Recorder
VHF	-	Very High Frequency
VTS	-	Vessel Traffic Services
WOC	-	Western Operations Centre
Hot work	-	Work processes involving sources of ignition or temperatures high enough to cause ignition of gases, liquids or solid materials. Examples of hot work include welding, brazing, gas cutting and grinding.
Mousing	-	A method of securing a shackle pin, or similar pin, using a single length of light seizing wire

Times: All times used in this report are UTC+1 unless otherwise stated

SYNOPSIS

Maersk Newport sailed from Le Havre for Algeciras just after midnight on 10 November 2008 in force 4 to 5 winds. Overnight the weather deteriorated and the ship's speed was reduced. By 1200 the wind had further increased to force 8 to 9 with rough seas. At 1250 the bow thruster room bilge alarm sounded and a number of holes were found in the port side of the bow thruster room shell plating through which water was pouring. The port anchor chain lashing was found to have released and the anchor had fallen, against the windlass brake tension, into the water. As the ship continued to pitch in the heavy seas, the anchor impacted against the hull, causing the damage. It was later found that five adjacent compartments had also flooded.

Despite the forecasted poor weather conditions no specific heavy weather checks had been carried out. By the time they were considered necessary it was too dangerous for personnel to go on to the deck, so the anchor securing arrangements were not verified. The port anchor chain lashing arrangement failed because neither it, nor the windlass brake, was sufficiently tightened and the hawse pipe cover was not fitted.

The vessel continued her passage and arrived at Algeciras on 13 November for cargo operations and repair. Repairs were arranged by the technical superintendent with little input from the ship's crew. Unbeknown to the crew, oxy/acetylene metal cutting by shore contractors had been arranged for when the ship was alongside and engaged in cargo operations. At about 0055 on 15 November, the contractor's safety watchman left the forecastle and, by 0110, a fire had developed in the vicinity of the port windlass winch mooring rope and a bank of 15 acetylene bottles. One oxygen and two acetylene bottles exploded in the fire, which was extinguished at 0546. There were no injuries. Damage was restricted to the forecastle area. The cause of the fire is likely to have been a discarded cigarette which ignited contractors' clothing in the vicinity of the mooring rope and acetylene hoses.

Because of poor communications, no shipboard Permit to Work control measures were in place for the planned hot work, and the contractor's safety watchman had no emergency communication link with the crew. He left his safety station without the knowledge of the foreman, so the fire was not discovered for about 15 minutes. The gas cutting assemblies were not leak tested and the "in use" gas bottles were co-located with the remaining bottles increasing the risk of fire spread.

Neither accident was reported to the Marine Accident Investigation Branch (MAIB) or to the management company's Designated Person Ashore (DPA).

Recommendations have been made to A.P. Møller Maersk which include a review of internal and external communication procedures, control of contractors, hot work arrangements and accident reporting procedures. The company has also been recommended to issue instructions on preserving voyage data recorder information for accident investigation purposes.

The repair contractor has been recommended to ensure that no flammable material is left near gas bottles, its workers are equipped with Very High Frequency (VHF) radios, a safety watchman is always available, that gas connection leak tests are carried out and, where feasible, "in use" bottles are separated from those in the storage area.

Maersk Newport

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *MAERSK NEWPORT* AND ACCIDENT

Vessel details

Registered owner	:	The Maersk Company Limited
Manager	:	A.P. Møller Maersk a/s
Port of registry and flag	:	London, United Kingdom
Type	:	Container ship
Built	:	Volkswerft Stralsund GmbH Germany. In service September 2008
Classification society	:	American Bureau of Shipping
Construction	:	Steel, to ship design VW 2500
Length overall, breadth	:	210.49m, 29.88m
Gross tonnage	:	25888
Engine type, power and propulsion	:	Single, 7 cylinder MAN-B&W 7L70ME-C, 2 stroke engine. Power output 21770 kW giving a service speed of 22.1 knots. One fixed propeller and 1100 kW bow thruster

Accident details	:	
Times and dates	:	1250 on 10 November 2008 (heavy weather damage) and 0100 on 15 November 2008 (fire)
Location of incident	:	49^{o} 26.7'N 004^{o} 19'W – 50 miles west of Guernsey and 36^{o} 8.92'N 005^{o} 26.1'W at the APM Terminals Algeciras, Spain
Persons on board	:	10 November 2008 - 22 crew on board. 15 November 2008 - 22 crew, 8 contractors and an unknown number of stevedores
Injuries/fatalities	:	None on 10 November 2008. Single case of slight smoke inhalation on 15 November 2008
Damage	:	Heavy weather - hull penetrations and flooding, water contamination of electrical equipment Fire – two mooring ropes destroyed, deck plating distorted, heat damage to the winch coatings

1.2 BACKGROUND

1.2.1 Vessel overview

Maersk Newport was built to an A.P. Møller Maersk design and was one of five "N" Class container ships planned for service with Maersk Line. Two had been built with the third planned for delivery in November 2008, and the last two during early 2009. Because of changing trading patterns, three of the class had since been sold to another shipping company within the Maersk group for registration in Brazil. A number of sister vessels, of slightly increased gross tonnage, were in service with Safmarine, which was also part of the A.P. Møller Maersk group.

Maersk Newport was designed to carry 2150 standard containers and up to 600 refrigerated containers. She operated a "dry" firemain, which meant that the fire pump had to be manually started in the event of a fire. At the time of the heavy weather damage the bow thruster was defective and was awaiting repair under the shipbuilder's guarantee procedures.

Maersk Newport was classed with Lloyd's Register until September 2008. She was then transferred to the American Bureau of Shipping (ABS) classification society.

A general arrangement drawing of *Maersk Newport* is at **Figure 1**.

1.2.2 Additional crew

For the passage from Le Havre to Algeciras there were three additional officers on board. The off-going chief engineer, chief officer and second officer remained on board for an extended handover to assist with the incoming officers' ship familiarisation.

1.2.3 Shore management

Maersk Newport and her sister ship *Maersk Norfolk* were managed by the Copenhagen based A.P. Møller Maersk a/s Technical Organisation. Newcastle based Maersk Marine Services Limited (MMS) was the vessel's safety manager and the General Manager (Operations) of MMS was also the ship's DPA.

Trading was scheduled on a circular route between Western Europe, Algeciras and north-west Africa. Network planning and scheduling was the responsibility of Maersk Line Central Fleet Operations in Copenhagen. Scheduling compliance was managed by Maersk's Western Operations Centre (WOC) based in London.

1.3 NARRATIVE – PART 1 – HEAVY WEATHER DAMAGE

1.3.1 Departure from Le Havre

Maersk Newport arrived at Le Havre at 0902 on 9 November 2008 for cargo operations which extended throughout most of the day and evening. During the early evening the master obtained a weather forecast for the English Channel from the Netherlands based, Ships Performance Optimisation System (SPOS) website. It is reported that the forecast for the English Channel, for 10 November 2008, was for south-westerly force 5 to 6 winds which were expected to strengthen.

Pre-sailing checks were carried out between 2300 and midnight when the forward and aft draughts were recorded as 9.7m and 10.7m respectively. No specific heavy weather checks were made. The pilot embarked at about 2345. The bosun reported to the master that both anchors were secured, on the brakes alone, in readiness to let go in an emergency. The master, both chief officers and pilot were on the bridge when *Maersk Newport* slipped from her berth at 0001 on 10 November 2008.

The departure was uneventful, and after the pilot disembarked at 0056, the master ordered full away on passage, which equated to a speed of approximately 18 knots. The master then instructed the bosun to fully secure both anchors. The bosun subsequently reported to the master that the anchors were in their fully housed positions, that the lashing chains were tight, the guillotines blocks were down, the brakes were on as tight as possible and that the windlasses were out of gear. Neither of the two hinged hawse pipe covers or the two spurling pipe covers were fitted. The bosun then returned to the accommodation and reported to the officer of the watch (OOW) that he was off the deck. At 0118 the master increased speed to full sea speed (22 knots), before leaving the bridge to send business messages. The wind at the time was recorded in the Deck Log as south-westerly force 4 to 5.

After sending his messages, the master briefly returned to the bridge to confirm with the second officer that the speed was increasing, before going to bed.

Soon afterwards the weather began to steadily deteriorate. The wind speed increased to force 7 and the vessel was shipping water and spray as she pitched into the, now, rough seas. At 0340 the master was wakened by furniture moving in his cabin. He contacted the second officer on the bridge and was advised of the weather conditions. As a result, the master ordered the speed to be reduced to full ahead manoeuvring, which was about 15 knots.

Throughout the morning watch the weather continued to steadily worsen. At 0700 the ship's log recorded conditions as:

> *"rough westerly seas and swell, overcast and misty with the ship pitching moderately"*

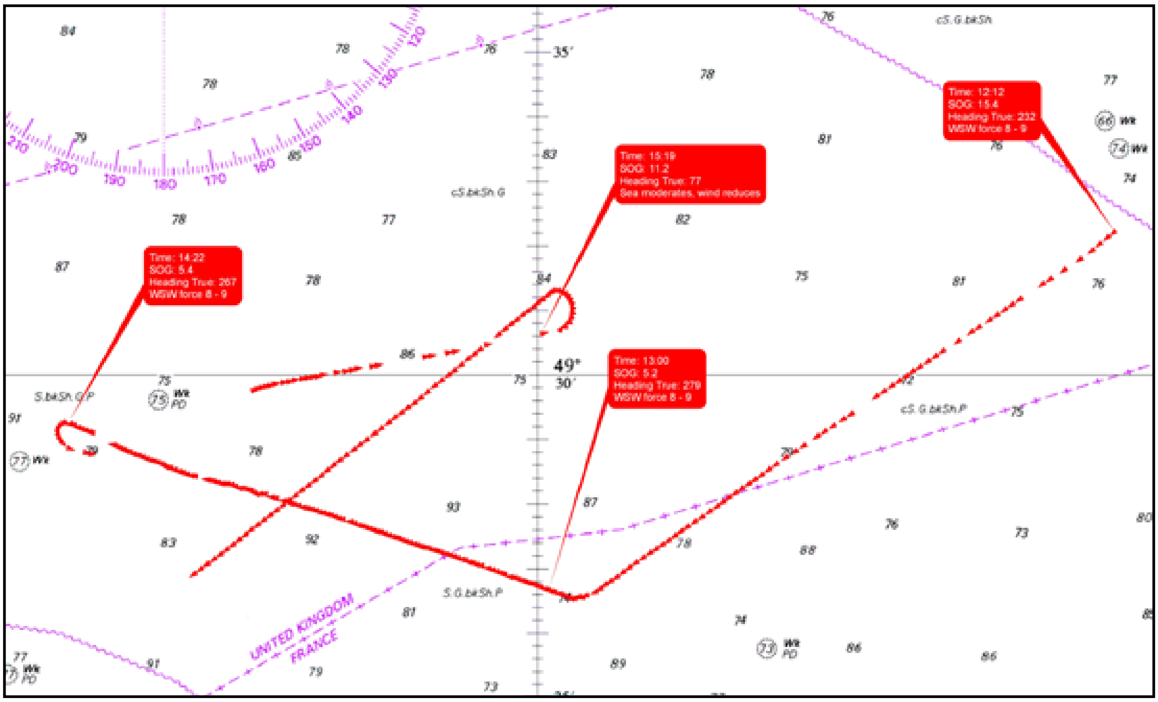
At 0800 the outgoing chief officer was sufficiently concerned about the weather conditions that he made a broadcast advising that the deck was out of bounds. He also posted a sign to that effect on the whiteboard outside the mess room. In addition, he advised the catering and engineering teams to secure their departments for expected heavy weather. Because of the dangerous conditions on deck it was not possible to carry out any checks of the cargo lashings, hatches or anchor securing arrangements.

At 1200 the engineer OOW completed a set of engine room rounds. Having confirmed the engine room was safe, he switched the Engine Control Room (ECR) alarm panel to the remote Unmanned Machinery Space (UMS) position before going to the officer's mess room for lunch.

The master had continually assessed the deteriorating weather conditions and ship's movement throughout the forenoon watch. By 1200 the west-south-westerly wind had increased to force 8 to 9 and the sea remained rough with a 0.8 knot east-north-easterly tide running. However, the ship was recorded in the Deck Log as "pitching and rolling easily" and the master decided that it was safe to continue the passage at full ahead manoeuvring speed. At 1212 the ship's Automatic Identification System (AIS) recorded the vessel's speed over the ground (SOG) as 15.4 knots on a heading of 232° true (T). A copy of the AIS generated track is at **Figure 2**.

AIS data courtesy of MCA

Figure 2



AIS tracks - 10 November 2008

1.3.2 Alarms and investigation

At approximately 1215 the remote UMS alarm panel in the officer's mess room sounded. The second engineer went immediately to the ECR and, on entering, he noticed a distinctive electrical burning smell. He saw that the UMS panel alarm was due to an indicated, high bow thruster motor temperature, despite the motor not running.

Having warned the chief engineer and electrician of the problem, the second engineer attempted to identify the cause of the electrical burning. As he did so, the 220 volt electrical supply breaker, supplying the forward section of the ship, opened and closed a number of times as earths were detected. The electrician arrived and the second engineer contacted the OOW on the bridge, and told him that the ECR was now manned and that he was trying to identify the true cause of the alarm and earths. At 1231 the chief engineer assisted the second engineer and electrician in opening the switchboard supply breaker panels to try to identify any defects which could explain the cause of the burning smell, the alarm and the earth conditions.

At 1250 the bow thruster room fire alarm sounded on the bridge. The master went immediately to the bridge. He reduced speed to slow ahead and altered course to provide safe access across the deck, so that the cause of the bow thruster compartment fire alarm could be investigated. At 1300 the SOG was 5.2 knots and the ship's heading was 279^{o}T – **Figure 2**. The master then authorised both chief engineers, the outgoing chief officer, fourth engineer, bosun and electrician to go forward to the bow thruster room.

The outgoing chief engineer cautiously opened the bow thruster room hatch and, as there was no evidence of a fire, he went down the ladders. As he descended he immediately noticed three, 150mm by 250mm, holes in the port side of the hull. As the vessel pitched, water was sprayed into the compartment and over the electrical distribution and control panels. The chief engineer also noticed that there were numerous hull indentations **(Figures 3 and 4)** and that the bilge was full of water. He reported the damage to the master on the bridge and that he suspected that the port anchor had been released, causing the damage. He then instructed the fourth engineer to return to the ECR to fully isolate the electrical supplies to the bow thruster room. The bilge suction valve was opened and the 5 ton/hour bilge pump was started in an attempt to lower the water level.

The bosun was sent to get wooden wedges and neoprene rubber with which to stem the flow of water. On his way he went to the forecastle head with the incoming chief engineer and chief officer to investigate the damage from the outside. On looking over the port side, the port anchor was seen to be below the sea surface, and there were numerous indentations and splits in the vicinity of the port side of the bow thruster room. As the bow pitched, water was seen spraying out from more holes in the forepeak area, **Figure 5**.

Although it was clear that the anchor had caused the damage, the ship was still shipping seas, making it unsafe to access the forecastle to recover and secure the anchor. The anchor was well below the surface of the water and there were no reports of impact noise, and so the master concluded that no further damage was occurring. Consequently he opted for his team to continue to try to stem the water ingress. He also instructed them to take soundings of the tanks

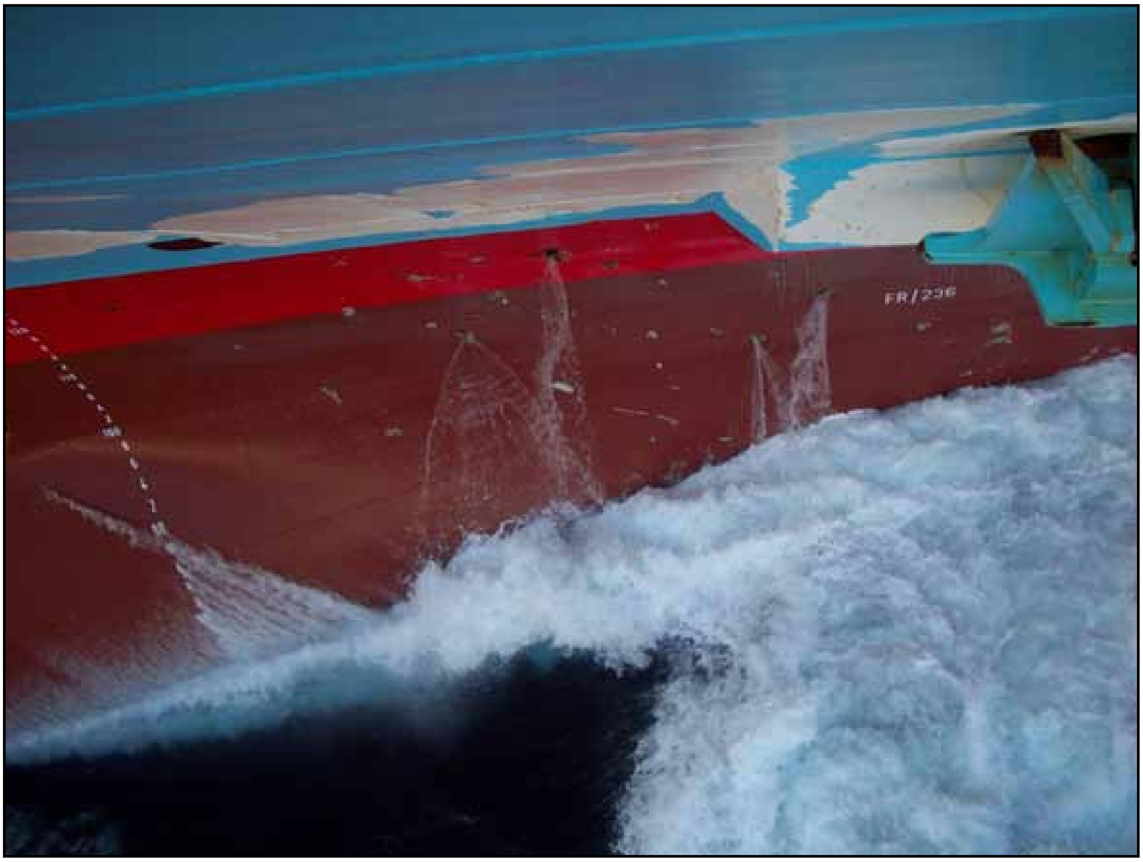
Figure 3

Hull indentations - port side bow thruster room

Figure 4

Hull indentations - port side bow thruster room

Figure 5



Damage to the port side of the hull seen from the forecastle

around the bow thruster room, and to ballast the vessel using the after ballast tanks. Meanwhile he manoeuvred the ship clear of the shipping lanes, at slow speed and onto a safe course to recover the anchor.

At 1307 the master e-mailed the technical superintendent in Copenhagen and the WOC with a preliminary damage report. However, he did not alert the DPA to the vessel's situation and did not consider carrying out the "save" procedure for the ship's Voyage Data Recorder (VDR).

1.3.3 Damage repair and anchor recovery

By about 1400 the team in the bow thruster room had managed to significantly reduce the inflow of water **(Figure 6)**. The bilge water at this point was about 1.25m deep and appeared constant, so the engineering team believed that the bilge pump was coping with the rate of water ingress. In the meantime, the ship was ballasted with about 400 tonnes of sea water using the after ballast tanks.

At 1422 the master altered course to allow access on to the forecastle. At 1432 the ship's head was 077° (T) **(Figure 2)**, the pitching was minimal and the master gave permission for the outgoing chief officer, the incoming chief engineer and the bosun to go on to the forecastle to recover the port anchor and to try to identify the cause of its release.

Figure 6

Example of bow thruster room damage control measures

The forecastle team found that about ½ to ¾ shackle of the port anchor cable had been released. The lashing chain Senhouse slip tapered securing pin had become detached from the slip and was hanging by its chain **(Figure 7)** and that the lashing chain was hanging loose. It was also found that the forward guillotine block was in the upright open position while the after guillotine block was in the horizontal closed position – **Figure 8**. Before the anchor cable was recovered, the chief officer checked the winch brake and managed to apply one full turn of the brake handwheel. After the port anchor was fully secured, checks were made to confirm that the starboard anchor was also fully secured.

The outgoing chief engineer reported to the master that the water level in the bow thruster room was steady and that the wedges were holding; but the electrically driven emergency fire pump had become contaminated with sea water and could not be used. He also advised him that all electrical supplies to the room had been isolated, including the fire detection heads, and as a result the electrical earth conditions had been resolved.

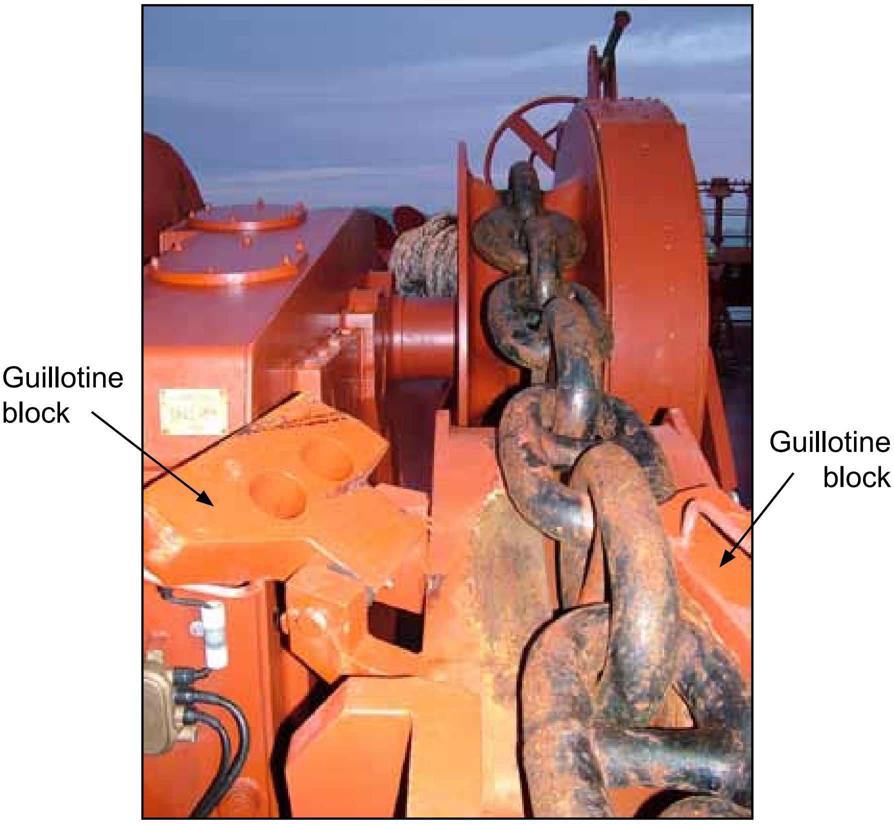
1.3.4 Passage to Algeciras

Having satisfied himself that the situation had stabilised, the master altered course at 1519 to resume his passage, at full sea speed, to Algeciras **(Figure 2)**.

Figure 7

Senhouse slip securing pin in detached position

Figure 8



Position of the port anchor guillotine blocks

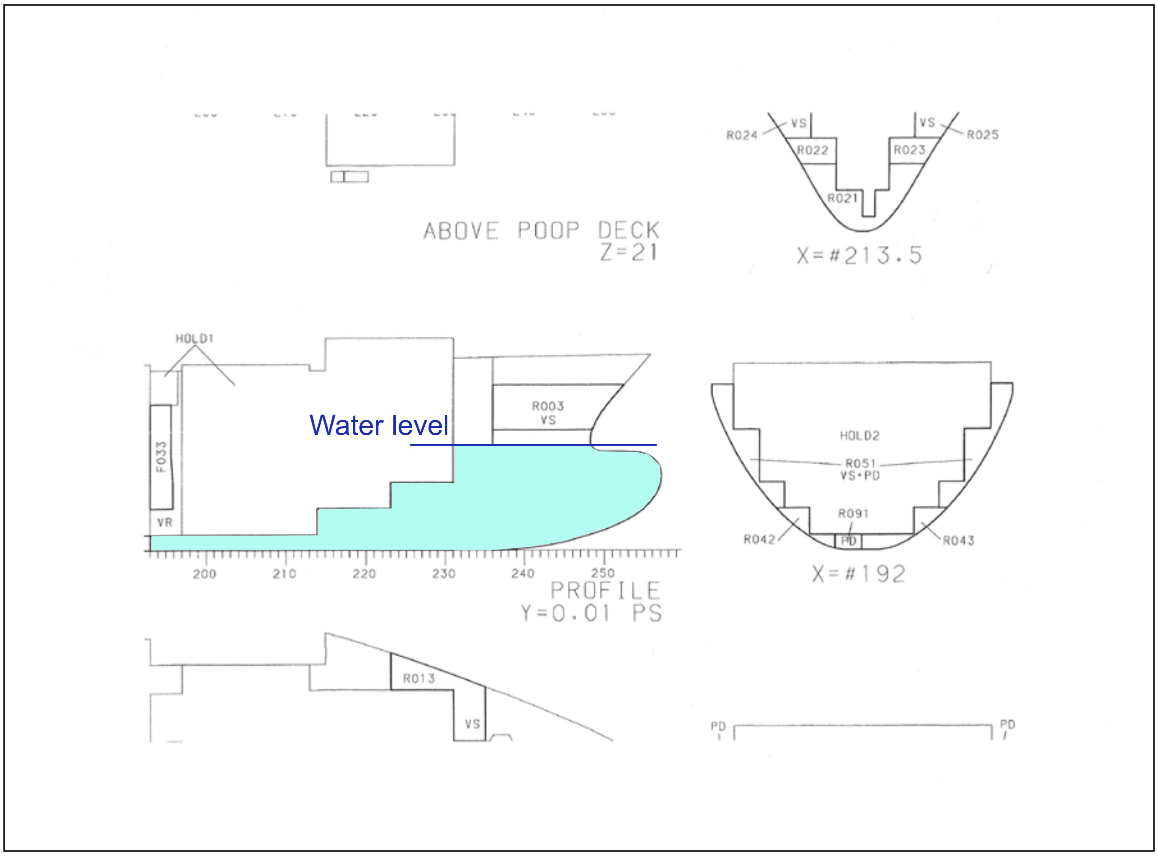
At about 1600 the Maersk shore technical management team in Copenhagen convened a Casualty Committee meeting involving technical, insurance, nautical and Maersk Line representatives. It was agreed that *Maersk Newport* should continue her passage to Algeciras for cargo operations and repair which were being arranged by the technical superintendent. The ship's DPA was not party to these discussions or arrangements, and no action was taken to advise the MAIB of the situation.

The water level in the bow thruster room was constantly monitored throughout the remainder of the day and night and was found to be slowly rising. By late evening the following tanks/spaces were found to have been breached (**Figure 9**):

Bow thruster room	R001 - Forepeak
R003 - Void space above forepeak	RO21 – Centre ballast tank
R033 Cargo hold bilge tank	

Table 1 – Breached tanks/spaces

Figure 9



Ship's section showing extent of flooding

At 0800 on 11 November the bow thruster room water level had increased to the top of the bow thruster motor pedestal. By 1200 the level had increased by a further 2m, and by mid-afternoon the level was at sea level, suggesting to the engineers that there was at least one additional, undiscovered hole.

At 1348 the master submitted his casualty report, by e-mail attachment, to both the technical superintendent and the DPA. However, the attachment could not be opened because of the unique file extension. The report was later resent to the technical superintendent in a readable format but not to the DPA. A copy of the report is at **Annex A**.

Later in the afternoon of 11 November a fire drill was carried out to familiarise the incoming officers with the emergency equipment, its location and the ship's organisation.

The remainder of the passage to Algeciras was uneventful.

1.4 NARRATIVE – PART 2 – FIRE

1.4.1 Repair arrangements

During the afternoon of 11 November the technical superintendent requested the Maersk agent in Algeciras to arrange a lay-by berth for the arrival of *Maersk Newport.* This was to enable a divers' inspection of the hull, and to carry out a survey to determine the extent of repairs. The agent was also requested to arrange a lay-by berth after completion of cargo operations, planned for 14 November, in case the repairs had not been completed by then **(Annex B)**.

ABS was notified of the damage and it advised that a surveyor would attend on the vessel's arrival. The technical superintendent also contracted Servyman Del Estrecho S.L. (hereafter termed Servyman), a reputable engineering company based in Algeciras, to carry out the hull repairs and to remove the defective electrical equipment for repair.

On 12 November Maersk's agent applied to the Algeciras Port Authority's (APA) Head of Inspection and Survey for approval to carry out "hot work" in accordance with APA's requirements. The proforma request, which did not include the required declaration of dangerous goods (DG) **(Annex C)**, was granted on 13 November and the certificate faxed to the agent, which was then passed to Servyman. A copy of the certificate and the subsequent English translation provided by the agent is at **Annex D**[1].

Maersk's agent confirmed with Servyman that a lay-by berth, at Dique Norte, had been arranged for the ship's arrival and that she would be moving to the Maersk Container Terminal at Muelle Juan Carlos I Este for cargo operations at about 2100 on 14 November. The layout of the port showing the berths is at **Figure 10**.

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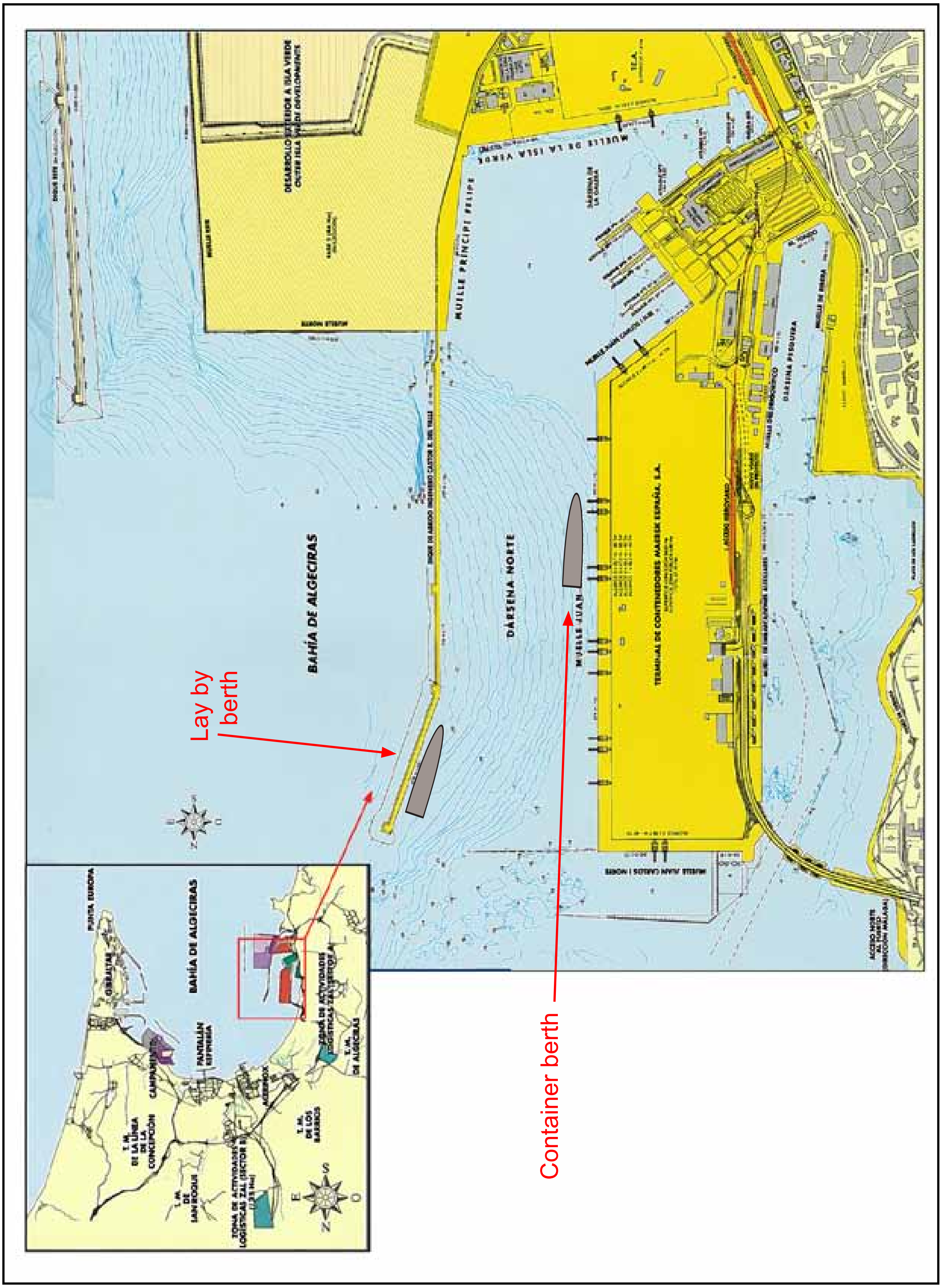
[1] The certificate was dated 6 November 2008 in error and should have read 13 November 2008. The fax header on the certificate confirms that it was sent at 1203 on 13 November 2008

Figure 10



Layout of the Port of Algeciras

1.4.2 Damage survey and repair preparations

Maersk Newport arrived at the lay-by berth at 0200 on 13 November 2008. During the forenoon the divers completed their inspection and identified six holes that had penetrated the 15mm hull shell plating. These were temporarily covered with epoxy to enable Servyman to pump out the compartments and to allow for an internal survey by the ABS surveyor, the Maersk technical superintendent, an attending Maersk electrical superintendent and Servyman.

The survey identified numerous indentations and scoring of the shell plating **(Figure 11)** and more severely damaged areas that required 23 insert plate[2] repairs, to enable the ship to sail from Algeciras without a "Condition of Class". The locations of the insert plate repairs are shown at **Figure 12**.

During the day, the sea water contaminated electrical systems were washed through with fresh water. The bow thruster and emergency fire pump motors were removed for decontamination in shore workshops and Servyman transferred repair equipment on to the vessel.

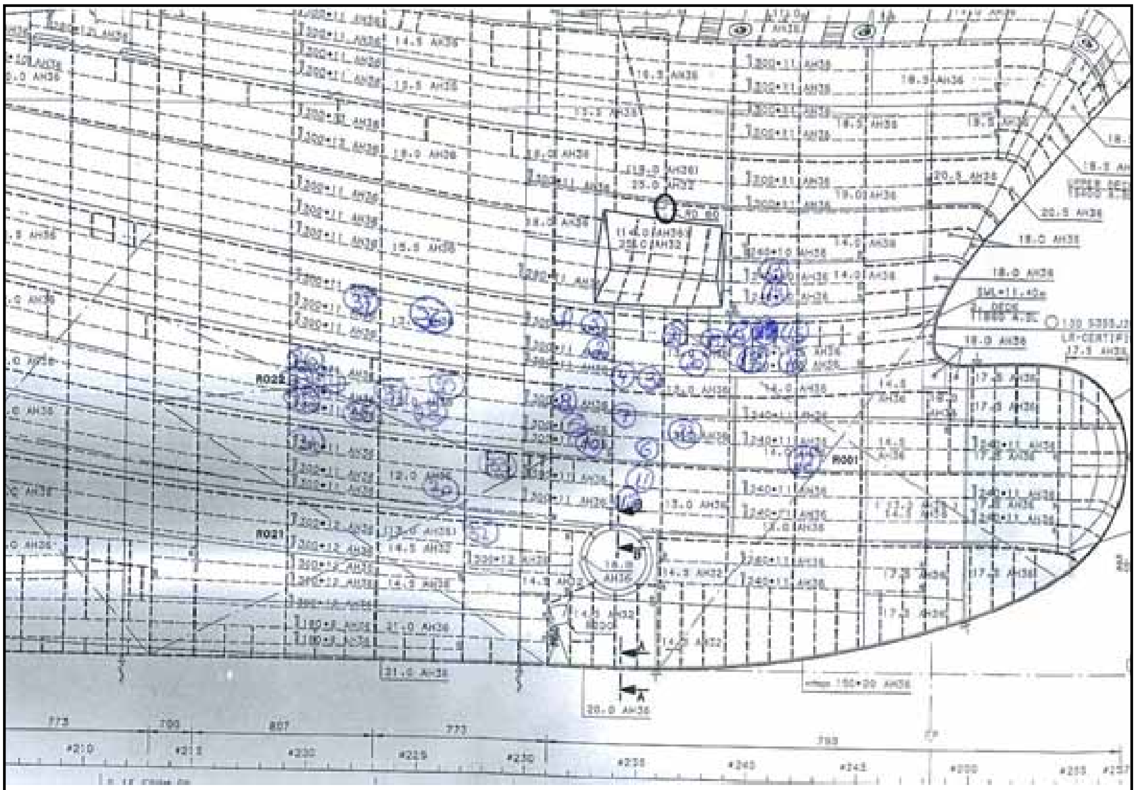
Image courtesy of Algeciras Port Authority

Figure 11

Hull indentations

[2] This was later revised to 21 insert plates as the close proximity of some of the damaged areas were combined within one insert plate.

Figure 12



Location of insert plate repairs

The Maersk agent also delivered APA's hot work approval certificate, which was in the Spanish language, to the master.

During the early evening of 13 November a "Plan of the Day" meeting[3], chaired by the technical superintendent, was held on board the ship to determine the repair programme and to discuss the day's findings. The meeting was attended by the technical and electrical superintendents, master, chief officer and chief engineer. A representative of Servyman did not attend. The issue of when hot work was to start was not discussed nor was the requirement to comply with the hot work procedures. The technical superintendent then reported the day's progress to Maersk headquarters in Copenhagen.

During the morning of 14 November Servyman continued to transfer repair equipment on board. This included 15 acetylene and 16 oxygen bottles, in separate cages, which were craned on board and placed on the forecastle. These were to be used for gas cutting out the damaged areas of the hull. Other equipment included argon equipment to be used for welding the insert plates, electrical transformers, lighting, extraction fans and grinders.

[3] The technical superintendent intended to hold a Plan of the Day meeting each morning but decided not to do so on 14 November because there was no change to the plan overnight of 13/14 November.

1.4.3 Repair programme changes

The technical superintendent initially gave Servyman a 5 day repair window. However, during the morning of 14 November this was revised by Servyman to 8 days because of the amount of work. It was agreed with the technical superintendent that this would be kept under review and reduced if possible. In order to expedite repairs, 2 x 12 hour shifts were to be worked starting at 0800 and 2000. It was planned to start shift work that evening, which would include hot work while the ship was alongside and engaged in cargo operations at the container berth. However, the superintendent instructed that the damaged areas should not be completely cut out because this would compromise the ship's watertight integrity as she returned to the lay-by berth.

At 1218, Servyman advised the ship's agent and the Maersk Terminal Planning and Security Departments of the intention to carry out work at the cargo terminal without interfering with cargo operations **(Annex E)**. The correspondence indicated that hull plates would be renewed but did not specifically state that hot work would be conducted.

During the afternoon of 14 November the technical superintendent believed he informed the master, chief officer and chief engineer, in passing, that preparation work would continue at the cargo terminal and that this would include hot work. However, none of the officers could recall any reference being made to hot work. Later in the afternoon the chief officer indicated to Servyman's electrician that he could connect into the ship's electrical supply at a 440v junction box behind the breakwater bulkhead.

1.4.4 Shift to the cargo terminal

The contractors left the ship at about 1800 and returned to their workshop to hand over to the night shift. The technical superintendent went back to his nearby hotel at about 1800 but the electrical superintendent remained on board. At 1900 *Maersk Newport* shifted from the lay-by berth to Maersk's container terminal, to discharge her entire cargo, so that the damaged areas of the hull would be clear of the water to enable the full repairs to be carried out.

The vessel was alongside the berth at 1930 and cargo operations started at 2000. As the chief officer assumed his cargo duties he advised the second officer, who was the OOW, that contractors would be working a night shift on board the vessel effecting preparatory repair work in the forepeak and bow thruster room. The OOW acknowledged this.

1.4.5 Contractor's night shift work

At 2045, Servyman's night shift, comprising a foreman, electrician and six burners/welders/labourers signed the gangway Visitors Log and went on board. Three of the contractors are known to have smoked cigarettes.

The electrician, who was a non-smoker, and who was also the "on deck" safety watchman, connected his 220v electrical transformer to the ship's 440v electrical supply. He then connected to the transformer outlet supplies: three extraction ventilation fans, two for the forepeak and one for the bow thruster room; and two grinders, one for the forepeak and one for the bow thruster room.

In the meantime three sets of burning hoses (three oxygen and three acetylene) were connected to the regulator outlets of bottles located in their respective storage cages. The oxygen regulators were set at 5 bar and the acetylene regulators at 1.5 bar. Two sets of hoses were taken down to the forepeak and one set into the bow thruster room. None of the bottle to hose connections was subjected to any form of leak testing. The layout of the equipment, including the forward mooring arrangements is shown at **Figure 13**.

The OOW visited the forecastle area at 2100 and saw nothing to cause him any concern. The burning out of the defective hull sections started at about 2115. None of the contractors informed any of the ship's staff that hot work had started.

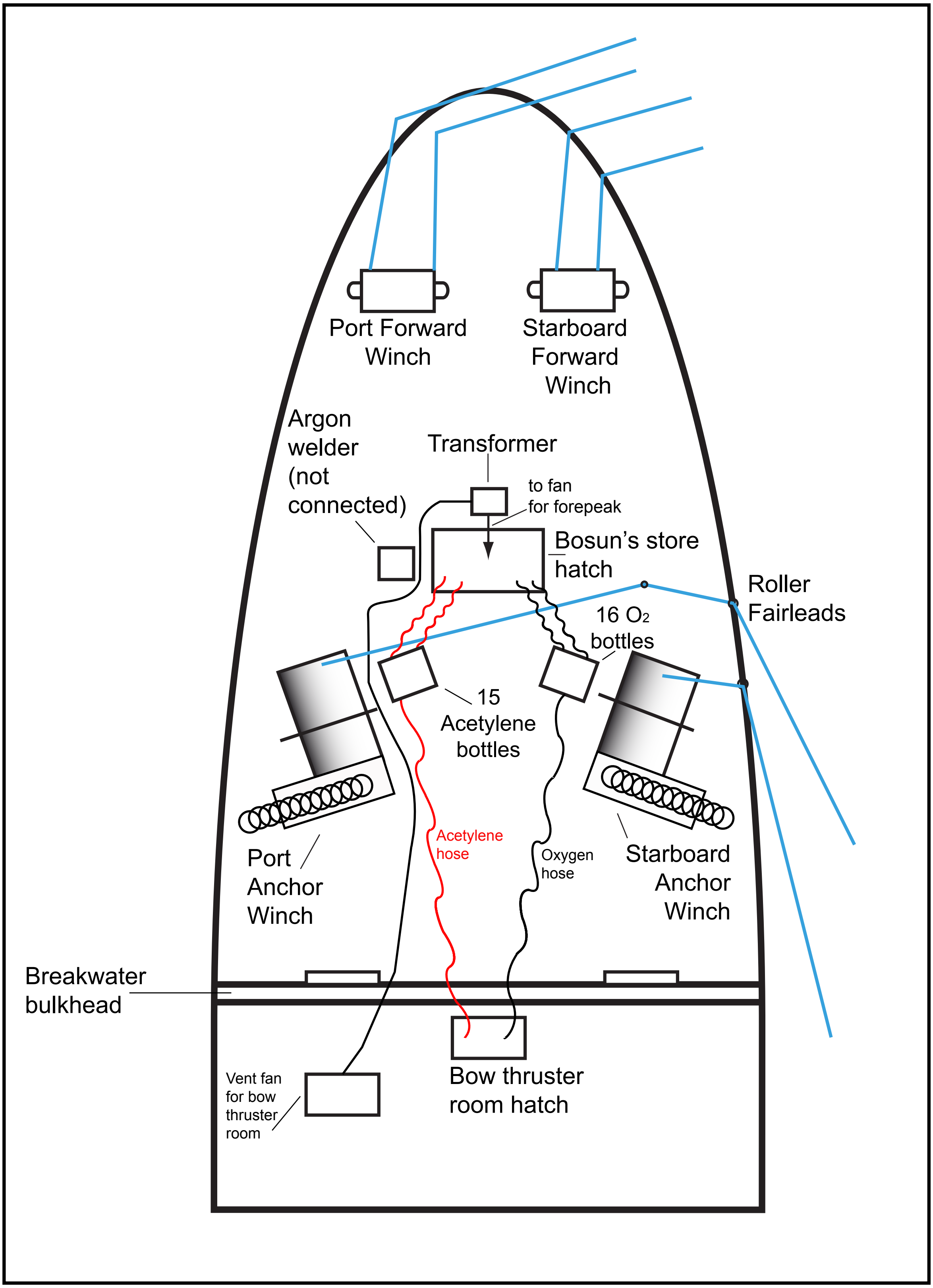
The burning process progressed satisfactorily, however, the foreman decided to reduce the number of blowtorches in use in the forepeak, from two to one, because of the limited space in the compartment. The applicable oxygen and acetylene bottle valves were shut and the blowtorch was disconnected from the hoses; however, the hoses remained connected to the bottle regulators.

The foreman regularly moved between the forepeak and the bow thruster room to check on progress. In doing so he passed the gas bottles and electrical equipment on the forecastle and noticed nothing untoward. Progress was satisfactory, but instead of leaving the plates in place with a small amount of material at the corners, as agreed between the technical superintendent and Servyman's workshop foreman, the whole section was burnt out, leaving a number of large holes in the ship's side.

The contractors stopped work at 2235 and left the ship for their meal break. The blowtorch valves and the two acetylene and two oxygen bottle valves were shut. At 2330 the OOW once again visited the forecastle area and found nothing to concern him.

The contractors returned at 2345 and continued burning out the damaged hull sections. Just after midnight the OOW handed over his watch to the outgoing second officer and, in doing so, advised him that the contractors were in the forepeak and the bow thruster room. He did not advise that hot work was ongoing because he was unaware of this.

At about 0055 the burning stopped in both the forepeak and the bow thruster room. The blowtorch gas valves were shut, but the gas bottle valves were left open as the contractors started to grind off the rough, burnt edges of hull plating.



Diagramatic layout of the contractor's equipment and forward mooring arrangements

Very soon afterwards the electrician/safety watchman left the forecastle area and went into the ship's accommodation to use the toilet facilities. He did not inform the foreman of his intentions, and contractors and their equipment were left without a safety oversight. On passing through the port access in the breakwater bulkhead the electrician/safety watchman noticed four, unidentified, stevedores about 25m aft of the gas bottle storage area. He was unsure if they were smoking at the time.

1.4.6 Discovery of the fire

Just before 0110 the foreman, who was in the forepeak, decided to visit the bow thruster room to check on progress. As he was about to pass through the hatch to the upper deck from the bosun's store, he saw sparks coming down the hatch, so he quickly retreated. He called to the electrician/safety watchman, but received no reply, so he contacted him on his mobile telephone to find out the cause of the sparks, which by now made his exit route extremely dangerous. The electrician/safety watchman told the foreman that he was in the accommodation. He thought the foreman's indication that there may be a fire was a joke, so he did not immediately return to the forecastle.

A couple of minutes later, the Burner in the bow thruster room tried to ignite his blowtorch to continue cutting. He found that the acetylene pressure had dropped off, so he sent his assistant to the upper deck to check the reason for this. As the assistant approached the breakwater bulkhead access to the forecastle he was confronted by a fierce fire. He noticed the fire was in the immediate vicinity of the acetylene gas bottles in the storage cage, and also on a polypropylene mooring rope on the port windlass winch drum which was next to the acetylene bottles. Alarmed and frightened by what he had seen, he went straight back to the bow thruster room to warn the Burner of the fire. He also tried to alert the Foreman by mobile telephone, but as tensions rose he could not find his telephone and both the Burner and his assistant quickly made their way onto the upper deck.

The assistant shouted a warning to the Foreman, but this went unheard as the Foreman was in the process of warning the contractors in the forepeak to the possible fire. The Burner from the bow thruster room tried to shut off the acetylene bottle valves but, because of the intense heat, he could not get close enough. Instead, he rigged a fire-fighting hose from behind the breakwater bulkhead, with the intention of fighting the fire through the bulkhead access opening on to the forecastle. He turned the hydrant valve on but, unbeknown to him, it was a dry fire main system which required the fire pump to be started to provide the water supply, so he and his assistant retreated aft to alert the crew to the fire.

The Foreman assembled his four contractors in the bosun's store at about 0116. One of them looked through the hatch and confirmed that there was an intense fire; but he managed to get through the hatch and make a safe escape.

Now very concerned for his and the remaining contractors' safety, the Foreman contacted the electrician/safety watchman again and told him of the fire as they retreated away from the hatch.

1.4.7 Alarm

At about 0117 the electrician/safety watchman saw the fire from the cargo area as he was joined by the other contractors who had escaped. The gangway watchkeeper was told of the fire and he, in turn, immediately told the OOW, who pushed a fire alarm button outside the cargo office. The fire alarm was recorded on the alarm panel at 0118. The electrician/safety watchman then told the Foreman, by mobile telephone, that there was a fire and that the ship's staff had been informed. At the same time, the OOW contacted the APM Terminal's Operations Department on VHF radio channel 22A and advised it of the fire and of the need for fire brigade support.

In the meantime the stevedores had also informed the APM Terminal's Security Department of the fire. Vessel Traffic Services (VTS), Pilot Control and the agent were then informed, as was the local authority fire brigade. One of the terminal security cameras was trained on to the ship and at 0118:15 it recorded an acetylene bottle explosion **(Figure 14)**.

Image courtesy of APM Terminals Algeciras

Figure 14

Still of acetylene bottle explosion taken from the APM Terminal's security camera video recording

The master arrived on the bridge at 0120 and could see the glow of the fire. He was advised by the OOW that acetylene bottles were in the vicinity of the fire and that there were contractors trapped in the forepeak area. The master sounded the general alarm and the crew rapidly went to their muster stations as the remaining stevedores left the ship. The electrical superintendent also mustered on the bridge and he alerted the technical superintendent, who was in his hotel.

1.4.8 Fire-fighting, recovery of contractors and dangerous goods

The ship's fire parties were mustered at 0128, and by 0133 fire-fighting hoses had been rigged on the port and starboard sides leading towards the forecastle. Soon afterwards one of the ship's fire-fighting teams, wearing breathing apparatus (BA), and under the direction of the incoming chief engineer, approached the forecastle from the port side. He confirmed that the mooring rope on the port windlass winch drum was on fire, and that the locus of the fire appeared to be the acetylene gas bottle storage cage.

At 0138 the team started to fight the fire from the forecastle port access through the breakwater bulkhead, which provided a degree of protection from the fire. They quickly extinguished the fire on the mooring rope and then concentrated on cooling down the acetylene and oxygen bottles. As they did so the first of three harbour tugs, *V.B. Algeciras,* arrived and sprayed water over the forecastle. Meanwhile, at 0142 the incoming chief officer reported to the master that a second fire-fighting team was fighting the fire from the forecastle starboard access through the breakwater bulkhead.

Very soon afterwards the local authority fire brigade arrived on board. The officer-in-charge (OIC) went straight to the bridge for discussions with the master. At about this time the master of *V.B. Algeciras* reported a second explosion. At 0147 the master was advised that electrical supplies to the forecastle area had been isolated and that the remaining contractors had escaped onto *V.B. Algeciras* through the holes they had previously cut in the forepeak.

By this time, the Algeciras harbourmaster had arrived in the VTS offices to manage the incident, and his Head of Inspection and Survey had arrived on board *Maersk Newport* in his incident liaison capacity. At 0152 the master formally handed over the fire-fighting responsibility to the fire brigade. At 0154 the ship's fire-fighting teams were relieved by the fire brigade, who requested that the tug stop spraying water over the deck, and stand by to assist if needed. While the master concentrated on dealing with the fire-fighting efforts and safety of his crew and ship, the electrical superintendent liaised with the harbour authorities on behalf of the master.

The incoming chief officer presented the harbour authority's Head of Inspection and Survey with the DG list and advised that Bay 01 Deck, the bay closest to the fire, but separated by the breakwater bulkhead, held three containers of DG, Class 5.1 (oxidising substances), designated as UN 2014 (hydrogen peroxide). He also advised that Bay 02 Deck held two containers of DG, Class 8 (corrosive substances), designated as UN 1789 (hydrochloric acid). Because of the risk to the DG the fourth engineer and bosun checked No1 hold and confirmed that there was no discernible heat transfer and that the DG in Bays 01 Deck and 02 Deck were cool. The Head of Inspection and Survey advised the harbourmaster of his findings. While there was no immediate concern, it was decided to keep the three tugs immediately available in case the fire spread to the DG and the vessel had to be taken into open water as a precaution.

While the fire brigade continued to cool down the acetylene and oxygen bottles, the bosun's store was accessed. At 0236 it was confirmed to the master that the fire had not spread and was confined to the forecastle.

At 0252 the Head of Inspection and Survey recommended that the accessible acetylene bottles be dropped into the harbour to rapidly cool them down in view of the particular dangers associated with heated acetylene bottles. This was rejected by the OIC on pollution grounds. It was then decided to secure the fire-fighting hoses and direct the nozzles on to the acetylene and oxygen bottles and vacate the vicinity of the forecastle **(Figure 15)**.

Figure 15

Hoses rigged to cool down the acetylene and oxygen bottles

The technical superintendent arrived on board at 0253, having been delayed by the security cordon preventing access to the berth. At 0322 one of the crew reported that he was suffering from the effects of smoke inhalation. He was evacuated to hospital at 0356 for medical checks and returned on board at 0440 with no further ill effects.

By 0400 the fire had reduced and the harbourmaster stood down two of the three tugs. At 0544 a rubbish skip was transferred on to the forecastle and filled with water, and at 0546 the fire was confirmed to be out. The acetylene bottles were then transferred into the skip to cool them down. At 0557 the last tug was stood down. As the fire brigade personnel left the ship at 0605, the crew were instructed to constantly monitor the acetylene bottles and inform them if there was any increase in temperature.

1.4.9 Post fire actions

By mid-morning there had been no increase in the acetylene bottle temperatures. The acetylene and oxygen bottles and all the burning equipment were subsequently transferred to the contractor's workshops.

Cargo operations were completed later that day, and *Maersk Newport* was shifted back to the lay-by berth to complete repairs. She sailed at 0750 on 23 November for West Africa to resume her schedule.

1.4.10 Environmental conditions

The environmental conditions during the heavy weather accident on 10 November 2008 are described in the accident narrative.

At the time of the fire on 15 November 2008 the vessel was in sheltered waters. The wind was south-easterly force 4 (11-16 knots) and the visibility was good. The air temperature was 16^{o}C with a relative humidity of 67%[4].

1.5 FIRE RELATED DAMAGE

The fire resulted in damage to the forecastle structure, ship's equipment and contractor's equipment.

1.5.1 Ship structure and equipment damage

The fire caused severe deformation of about 1.5m^2 of the forecastle deck plating just to starboard of the acetylene bottle storage cage area.

The polypropylene mooring rope on the port windlass winch drum was burnt through and destroyed **(Figure 16)**. Another mooring rope, not in use at the time, was also destroyed.

Heat damage was caused to the port windlass winch paintwork and also to the electrical cables supplying the winch motor and its control system **(Figure 17)**.

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[4] There is no Spanish meteorological station based in Algeciras. The UK Meteorological Office advised that the Gibraltar Meteorological Office is the nearest station to Algeciras and this is where the temperature and relative humidity readings were obtained.

Figure 16

Fire damaged mooring rope from the port windlass winch drum

Figure 17

Fire damage to the port windlass winch

1.5.2 Contractor's equipment damage

About 10m of the contractor's three oxygen and acetylene gas hoses were burnt through **(Figure 18)**, but the remaining 40m were unaffected. The hose non-return valves and flame arrestors fitted to the bottle regulators had been largely destroyed as had most of the acetylene and oxygen bottle regulating valves.

Figure 18

Acetelyne and oxygen hose fire damage

The 15 acetylene and 16 oxygen bottles were damaged beyond use. Two of the acetylene bottles had exploded and many of the others suffered splits and severe distortion **(Figures 19 and 20)**. One oxygen bottle had exploded and the rest suffered from severe heat damage **(Figure 21)**.

Apart from a small amount of superficial scorching to a supply cable, the contractor's electrical equipment escaped damage.

1.6 POST FIRE INVESTIGATIONS BY SPANISH ORGANISATIONS

1.6.1 Algeciras Port Authority

A member of the Harbour Master's Safety and Inspection Department started an internal fire investigation during the morning of 15 November 2008. The damaged area was inspected before the contractor's equipment was removed,

Figure 19

Explosion damaged acetylene bottles

Figure 20

Distorted acetylene bottles

Figure 21

Fire damaged oxygen bottles

so it was possible to examine the individual items, including the contractor's electrical equipment. The equipment was found to be in good condition with no defects. While the investigator could not determine the cause of the fire, his inspection of the fire site concluded that the fire was restricted to the area between the two windlass winches and, significantly, this was where burnt remains of clothing and food were found.

1.6.2 Air Liquide Espana S.A.

Air Liquide S.A. is part of the international Air Liquide Group, which is a leading producer and supplier of industrial and medical gases and related services. The company manufactured and supplied the acetylene and oxygen to a local distributor in Algeciras from which Servyman received its supplies.

On 19 November 2008 an expert on burning equipment from Air Liquide S.A.'s Malaga office visited Servyman's workshops and examined the equipment that was in use at the time of the fire.

Although the cause of the fire and ignition source could not be identified, it was confirmed that the cause was not due to any defects on the burning equipment or to a flashback from any of the blowtorches. A copy of inspection report is at **Annex F**.

1.7 SAFETY MANAGEMENT SYSTEM

1.7.1 General

The International Safety Management (ISM) Code requires that ships over 500 gross tonnage operate a Safety Management System (SMS). A.P. Møller Maersk's SMS is known as the Global Ship Management System (GSMS). The GSMS contains policies, procedures and instructions which are critical to the safe management and operation of ships and for pollution prevention as defined by the Code. The GSMS is applicable to all A.P. Møller Maersk's ships.

The aspiration is that the English language GSMS will become available in a fully web based format available to all ships. Currently, a large number of ships are not equipped with this facility and receive updates via mailed CD-ROM discs.

1.7.2 Training

A.P. Møller Maersk arranged for ship's staff to receive GSMS training in a variety of ways to ensure familiarity with the system. Officers who attended training courses at the MMS offices in Newcastle received at least half a day GSMS training as part of the management, modular syllabus. Training was also provided by four fleet safety superintendents, one of whom visited each ship in the MMS fleet for 10 days each year. In addition, the GSMS itself has a "step by step" tutorial embedded in the information database and on the GSMS CD-ROM disc held by the master.

1.7.3 GSMS review procedures

The GSMS was subject to a continual review process. Each month, the Health and Safety, Security and Environment (HSSE) department based at Maersk's Copenhagen headquarters, designated a section of the GSMS to be reviewed by a number of masters.

The issues identified were discussed by the master, with his heads of department, at the weekly onboard Operations Meeting. They were then further discussed at the Safety Committee Meeting under the standard agenda item – "Master's Review of Safety Management System".

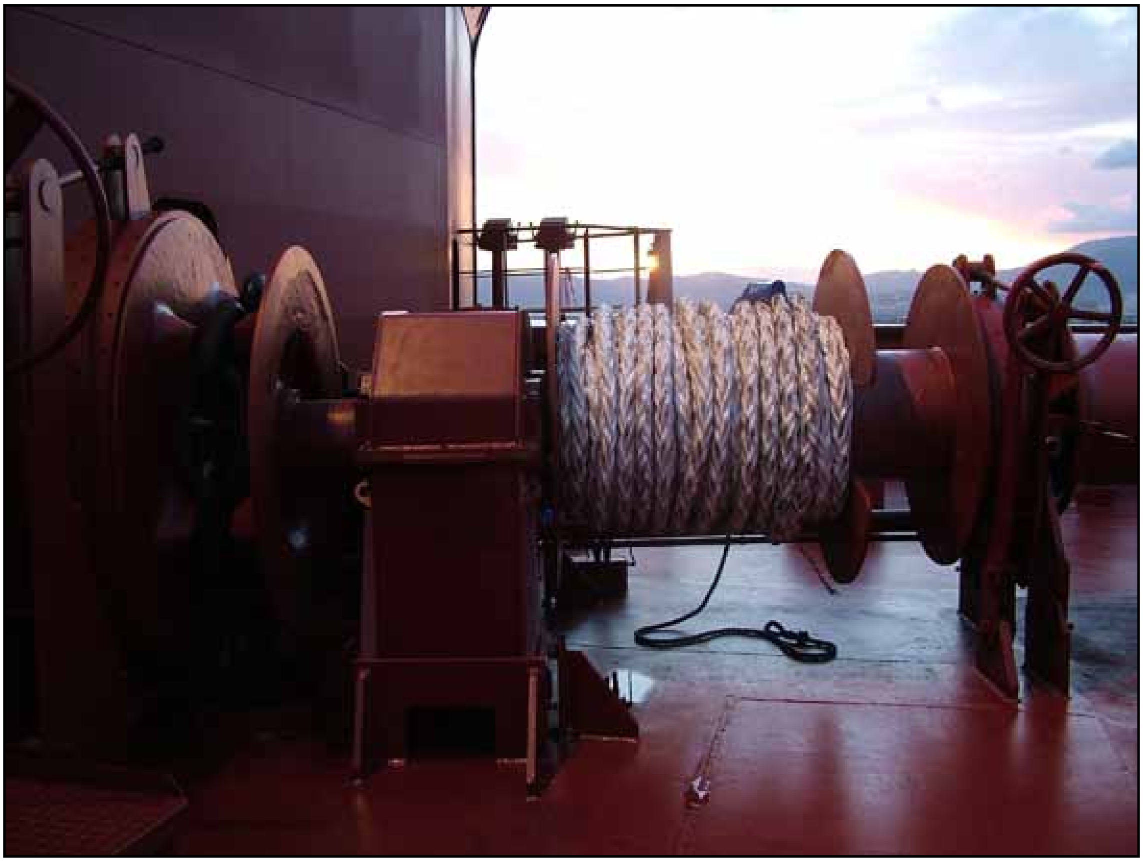
The Safety Committee Meeting minutes were forwarded to Maersk's HSSE department. Comments relating to the GSMS review were entered on to a central database and discussed at the 6-monthly GSMS Global Management Forum attended by all of the A.P. Møller Maersk group's shipping managers. The Forum made agreed amendments to the GSMS reflecting the wide input from users following changes initiated by the master's review process.

1.8 FORWARD MOORING ARRANGEMENTS

1.8.1 General description

Maersk Newport was fitted with two, type 2 AMW 120/76 K3 R, twin drum windlass winches on the forecastle **(Figure 22)**. The winches were designed and manufactured in 2008 by KGW Marine GmbH based in Schwerin in Germany.

Figure 22



General view of the port windlass winch

The system was designed for use with an anchor chain diameter of 76mm with a breaking load of 4295kN as specified in Lloyd's Register's Marine Design Appraisal Document dated 17 August 2007. The anchor itself had a mass of about 65kN. A hinged, non-watertight cover, secured by 2 threaded dogs, was fitted to the hawse pipe to help prevent the inrush of water in rough seas, as well as providing a general security function.

The windlass winch warping drum was divided into storage and working sections, and could be stopped using its dedicated manual band brake.

1.8.2 Anchor cable securing arrangements

Once the anchor was in its fully housed position, the anchor cable was secured by a 15mm chain lashing. The chain lashing and its components were manufactured to the approved Normenstelle Schiffs –und Meerestechnik DIN Deutches Institut für Normung e.V, VG 84504-1 standard.

The lashing was passed through the anchor chain and was secured to a quick release Senhouse slip. The moveable part of the slip link was secured by an 83mm long, slightly tapered pin which passed through the tongue of the slip **(Figures 23 and 24)**. The chain lashing was then tensioned by a bottle screw adjuster.

The windlass gypsy was also fitted with a large, manually operated band brake with a holding capacity of 1934kN, or 45% of the breaking load of the anchor cable.

Both windlass winches were fitted with two heavy guillotine blocks **(Figure 25)** which could be lowered to the horizontal closed position when the anchor cable was fully secured. The purpose of the blocks was to take the load of the anchor cable when the ship was at anchor by allowing the face of one of the horizontal anchor chain links to rest against the face of the guillotine blocks.

1.8.3 Securing anchors - normal sea condition

At sea, the anchor was normally secured in readiness for letting go quickly in an emergency. The band brake was applied as tightly as possible, the chain lashing was fully secured, the guillotine blocks were in the lowered position and the cable lifter drive clutch was disengaged. The operating manual procedure for raising and securing the anchor is at **Annex G**.

Section 4.2 Anchoring and Use of Anchors, ID 1383, of the GSMS **(Annex H)** reflects the operating manual instruction above, in specifying the anchor securing arrangements necessary before commencing a sea passage.

1.8.4 Control features

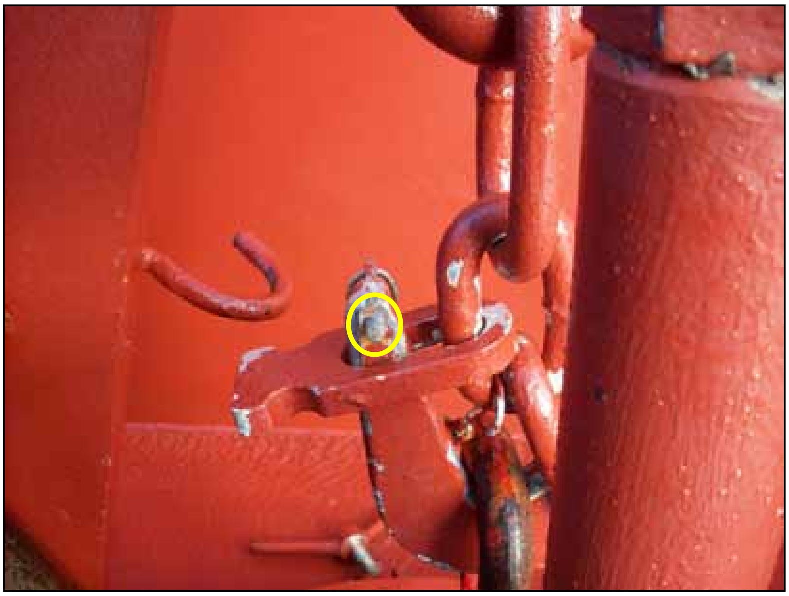
The cable lifter could be disengaged from the motor drive by a dog clutch to enable the anchor to be dropped quickly either for a planned anchoring or in an emergency. The anchor cable could also be veered out under power.

The winch warping drum drive was capable of manual and auto-tension modes of operation. The auto-tension mode was used to keep the ship alongside her berth by automatically heaving, or veering the mooring rope during changing conditions, i.e. wind strengths or water movement caused by passing vessels.

Figure 23

Chain lashing arrangement

Figure 24



Chain lashing Senhouse slip tapered securing pin

Figure 25

Guillotine block arrangement

1.8.5 Mooring ropes

The 150m long, forward mooring ropes were 62mm diameter, 8 strand with a minimum breaking strain of 823kN. Although commonly referred to as polypropylene ropes, they were a complex mix of materials. To increase wear resistance, each strand comprised yarn of 25% polyester and 75% a propriety material which itself comprised 87% polypropylene, 10% polyethylene and 3% ultra violet reducing agent. The core of each strand was 100% the proprietary material, while the outer circle of each strand was a 50/50 mix of the proprietary material and polyester.

The melting points of the materials are at Table 3.

Material	Melting Point ^{o}C
Polypropylene	160
Polyethylene	120
Polyester	260

Table 3 – Melting points of the mooring rope materials

1.9 VOYAGE DATA RECORDER

Maersk Newport was fitted with a Voyage Master II Sperry Marine voyage data recorder (VDR). The unit had a 12 hour memory which was automatically overwritten unless the "save" function was pressed.

The International Convention for the Safety of Life at Sea (SOLAS) Paragraph 6.2.a. of Annex 10 to Chapter V – Safety of Navigation identifies the importance and value of VDR stored information to the investigator. In particular the reference states:

> *"As the investigator is very unlikely to be in a position to instigate this action (saving data) soon enough after the accident, the owner must be responsible, through its on board standing orders, for ensuring the timely preservation of this evidence in this circumstance".*

Furthermore, Regulation 9(1)(c) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 requires the master and owner to, so far as is practicable, ensure that information from a VDR, relating to a reportable accident, is kept.

GSMS Section 4.4 Voyage Data Recorder (VDR) and Simplified Voyage Data Recorder (S-VDR) – ID 9874 **(Annex I)** provided an overview of the benefits and requirements of VDRs. Section 4.4.4 - Preservation of Records - emphasised that it was essential that masters, watchkeeping officers and accident inspectors were aware of the particular features of the VDRs fitted to ships.

1.10 HOT WORK ARRANGEMENTS

1.10.1 Onboard hot work arrangements

The general procedures for conducting hot work on board A.P. Møller Maersk ships were laid out in GSMS, Safety Rules for Hot Work Repair – ID1119 **(Annex J)**. Hot work in way of fuel tanks and fuel systems required the specific approval of the Technical Managers. As long as a safe distance of at least 3m was maintained from DG and fuel tanks and related systems, Technical Management permission was not required. The open deck, cargo holds, engine rooms and workshops were designated hot work areas and therefore Technical Management permission for hot work was not required.

In all cases of hot work, a written Permit to Work (PTW) was required before work started. The PTW was valid for only 24 hours, and its issue was preceded by a Safe Job Analysis (SJA).

The SJA was a risk assessment which aimed to identify the associated risks of carrying out the hot work. It identified controls that needed to be in place, i.e. system isolations, so as to reduce risks to as low as reasonably practicable. Before work commences a "Toolbox Talk" was required to be conducted so that those personnel involved were made fully aware of the scope of the work and their responsibilities, and that the instructions were understood.

A further essential part of the procedure was to monitor the progress of the work to ensure safe practices were adhered to.

The paragraph headed "Description" in ID1119 stated:

> *"The following safety rules detail the minimum requirements which shall be observed whenever repair work is undertaken on board whether or not the repairs are carried out by the crew* ***or by repairmen****".*

The "*following rules"* included the need for a PTW among other requirements.

1.10.2 Algeciras Port Authority arrangements

Before hot work could start on board a ship within the port limits, approval had to be sought from APA's Head of Safety and Inspection. The request was usually made by the ship's agent and included a declaration of the DG on board.

The approval, where granted, was in Spanish. There was no arrangement for the port authority to provide a copy translated into the onboard working language, in this case English. The approval was passed to the agent, who forwarded a copy to the ship concerned and to the contractors involved.

1.11 CONTROL OF CONTRACTORS

Contractors working on board A.P. Møller Maersk ships were required to complete an induction programme as laid out in GSMS – Induction Programme for Contractor's Employees – ID 0801 **(Annex K)**.

The programme was intended to ensure that contractors understood the onboard safe working practices and areas of responsibility. In particular, attention was required to be paid to the PTW and SJA procedures.

The instruction also specified that:

> *"It is the Chief Engineer's responsibility that local repairmen on board for the port stay are introduced to their task and receive proper safety instructions, and a clear explanation of the vessel's alarm signals and emergency assembly station"*

1.12 ACCIDENT REPORTING

The MAIB first became aware of the heavy weather damage and fire accidents during a routine review of the Lloyd's List of Casualty Reports dated 19 November 2008.

Neither of the accidents was reported directly to the MAIB or to the DPA by the master or any other part of the A.P. Møller Maersk organisation. Such accidents were required to be reported to the MAIB as soon as practicable in accordance with Regulation 6(1) of The Merchant Shipping (Accident Reporting and Investigation) Regulations 2005.

The accident reporting guidance applicable to container vessels was covered in GSMS sections "Fire – ID1147" and "Heavy Weather Damage – ID1148". Both references required the master to report the circumstances of the accidents to the appropriate Maersk technical and management organisations[5] as soon as possible.

Section 7.1.7 of the GSMS Technical Casualty Manual for Technical Organisation – ID 1183 **(Annex L)**, laid out the procedures for the shore management to report accidents involving British registered vessels.

1.13 USE OF OXY/ACETYLENE GAS

1.13.1 The oxy/acetylene process

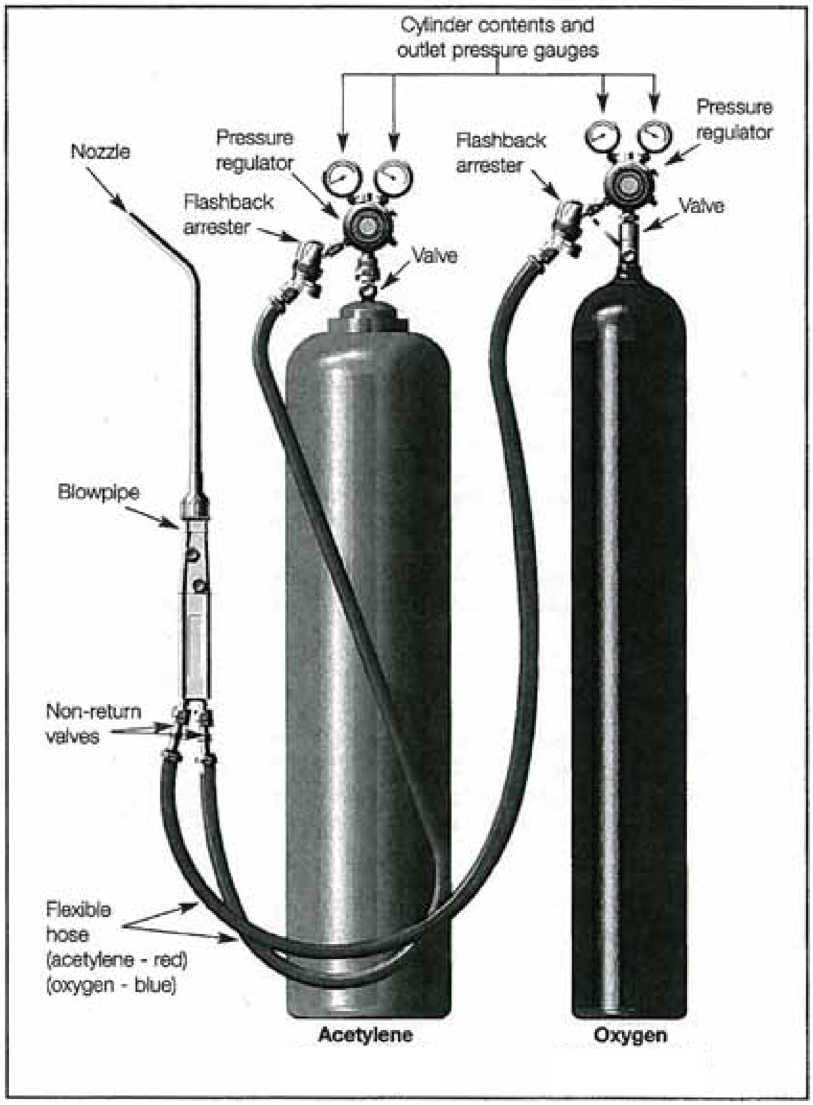
The oxy/acetylene process produces a high temperature flame, of over 3000°C, by the combustion of pure oxygen and acetylene. It is the only gas mixture hot enough to melt steel.

A typical oxy/acetylene burning/welding arrangement is shown at **Figure 26**.

[5] In this case management level should have included the MMS DPA.

Image courtesy of HSE

Figure 26



Typical equipment used in oxy/acetylene gas welding and similar processes

1.13.2 Purpose of flame arrestors, non-return valves and hoses

The flame or flashback arrestors and non-return valves, to EN 730 standard, were fitted to both the oxygen and acetylene hoses.

The arrestors comprised a sintered flame-arresting element, which acted to extinguish any flame coming in contact with it before it passed back to the gas bottle.

The non-return valves fitted to the hoses detected and stopped reverse gas flow preventing an inflammable oxygen and acetylene mixture from forming in the hose. The mixture could have travelled back to the regulators and possibly into the gas bottle, which, in the case of the acetylene bottle, would have promoted decomposition. The non-return valves were not designed to prevent a receding flame from travelling along a hose, towards the gas bottle, as could be the case in a flashback situation.

Hose lengths should be as short as is required for the task, and should be to EN 559 standard. A leak test should be carried out when connecting hoses to the bottle regulator to ensure the integrity of the system.

1.13.3 Acetylene gas and acetylene gas cylinders

Acetylene gas is extremely flammable and unstable. Air Liquide's Material Safety Data Sheet (MSDS) for acetylene properties is at **Annex M.** Of particular note are the:

- Need to keep away from ignition sources (including static discharges) – Sections 7 and 15 of the MSDS.
- Wide flammable range of the gas which is between 2.4 and 83 volume percentage in air - Section 9 of the MSDS.

Under certain conditions acetylene can decompose explosively into its constituent elements, of carbon and hydrogen. To reduce this risk a porous mass completely fills the cylinder. The acetylene gas in the cylinder is dissolved in acetone which is absorbed by the porous mass.

1.13.4 Decomposition

Acetylene decomposition can occur if:

- a cylinder is involved in a fire
- a cylinder is dropped
- the pressure in the hoses exceeds the manufacturer's recommendation – typically 1.5 bar
- if a flashback occurs and passes back into the cylinder
- the cylinder valve is leaking gas
- the gas is mixed with copper, silver or mercury

1.13.5 Safe storage

Oxygen and oxidizing chemicals will cause a fire to burn more fiercely, and a mixture of oxygen and a fuel gas can cause an explosion. To reduce this risk, stored oxygen cylinders should be separated from the stored acetylene gas cylinders by at least 3m, located in a non-smoking area free from combustible material and kept upright. It is also good practice to remove the "in use cylinders" from the storage area so that fire spread is less likely in the event of a flashback.

1.13.6 Backfire and flashback

A backfire (single cracking or ‘popping’ sound) occurs when the flame temporarily ignites the gases inside the blowtorch nozzle which self extinguishes. This may happen when the torch is held too near the work piece.

A flashback is far more dangerous and is accompanied by a shrill hissing sound. It occurs when the flame burns inside the torch. The flame may pass back through the torch mixing chamber to the hose. The most likely cause is incorrect gas pressures giving too low a gas velocity. Alternatively, a situation may be created by a higher pressure gas (acetylene) feeding up a lower pressure gas (oxygen) stream. This could occur if the oxygen cylinder is almost empty, but other potential causes would be hose leaks, loose connections, or failure to adequately purge the hoses.

The flame front which precedes the flame can exceed the pressure test of the acetylene hose and cause it to fail, with the result that the flame will become exposed. A flashback is typically evidenced by carbon deposits on the inside of the hose walls – **Figure 27**.

Figure 27

Carbon deposits on the inside of an acetylene hose - typical indications of a flashback

1.13.7 Leak testing

Gas leaks can occur on connections at bottle regulators and blowtorches. Damaged hoses, threads and bull nose interfaces are the most usual causes of leaks. While the European Industrial Gases Association (EIGA), Code of Practice Acetylene covers leak testing for large acetylene plants, it is less clear on the policy for single cylinder supply systems.

The British Oxygen Corporation's (BOC) Gas Equipment Operating and Safety Instructions[6] – Section 3 **(Annex N)** covers leak testing procedures applicable to newly assembled oxy/acetylene systems.

1.14 STATIC ELECTRICITY

Static electricity is a charge that accumulates on an object. Static electricity is often created when two objects, that are not good electrical conductors, are rubbed together, and electrons from one of the surfaces are transferred to the other. The ability of a material to accumulate a charge is especially dependent upon the smoothness of the surface and the humidity.

A rough surface in humid conditions is less likely to produce an incendive spark than a smooth material in dry conditions. However, sudden releases of built-up static electricity can take the form of an incendive electric arc and this is particularly so in the case of man-made materials such as polypropylene.

Chapter 3 of the International Safety Guide for Oil Tankers and Terminals (ISGOTT), 5th Edition, deals with static electricity issues. Section 3.1.1 of the Guide states that:

> *"Electrostatic discharges can occur as a result of accumulations of charge on:*
>
> - *Liquid or solid non-conductors, for example, a static accumulator oil (such as kerosene) pumped into a tank, or a polypropylene rope…"*

1.15 INDEPENDENT INVESTIGATION BY TENSION TECHNOLOGY INTERNATIONAL

The preliminary findings of the MAIB investigation identified that polypropylene mooring ropes were in use, in the auto tension mode, at the time of the fire. It is known that static electricity can be generated by materials rubbing against polypropylene, as briefly discussed at Section 1.14.

There has been very little research into evaluating whether static electricity stored in a polypropylene rope can produce an incendive spark sufficient to become a source of ignition, and further investigation was necessary.

1.15.1 Scope of the investigation

Tension Technology International (TTI), utilising its specialist sub-contractors Holdstock Technical Services, was commissioned to carry out two tests. The first was to determine:

- How much charge can accumulate on the surface of a polypropylene rope wound onto a steel drum while being charged using an external source.
- Whether an electrostatic discharge can be induced capable of igniting an acetylene/air mixture across its explosive range.

[6] Applicable to the United Kingdom and Ireland only

If the first test requirements were proven, then a second test was to be conducted to ascertain:

- If it is possible to create a surface charge sufficient to generate an incendive spark under the range of auto tension windlass winch operating conditions that were available on board *Maersk Newport*.

1.15.2 Investigation conclusions

The investigation report concluded that:

"The test results indicate that the rope under test, when wound on an earthed steel core, is not capable of retaining sufficient electrostatic charge to produce hazardous discharges".

A copy of Holdstock Technical Services' report is at **Annex O**.

1.16 SIMILAR ACCIDENTS – ANCHOR LASHINGS AND HEAVY WEATHER

There are records of two accidents with circumstances similar to the failure of the anchor securing system and one which also features the use of heavy weather checklists.

1.16.1 *Maersk Newport*

In early October 2008, the bosun found the starboard anchor chain Senhouse slip securing pin to be seized. The pin was driven out and greased up; however, a few days later the pin was found to have sheared. The chain lashing had released, but the anchor had remained secure on the brake. The tapered pin was subsequently replaced by a nut and bolt arrangement **(Figure 28)**.

1.16.2 *Safmarine Nyassa*

The A.P. Møller Maersk-owned *Safmarine Nyassa* was fitted with the same design of anchor securing arrangements. On 26 October 2008 the vessel had been heading into moderate to rough seas. The following morning the Senhouse slip securing pin was found to have sheared **(Figure 29)**, allowing the chain lashing to slip down the hawse pipe. On this occasion the anchor cable was held securely on the brake.

The securing arrangement was subsequently modified by using a bow shackle instead of a Senhouse slip **(Figure 30)**, and this was endorsed by the technical management team. However, there is no record of any representation being made to the manufacturer to highlight a possible design shortcoming. Neither was the shortcoming brought to the attention of the rest of A.P. Møller Maersk's fleet.

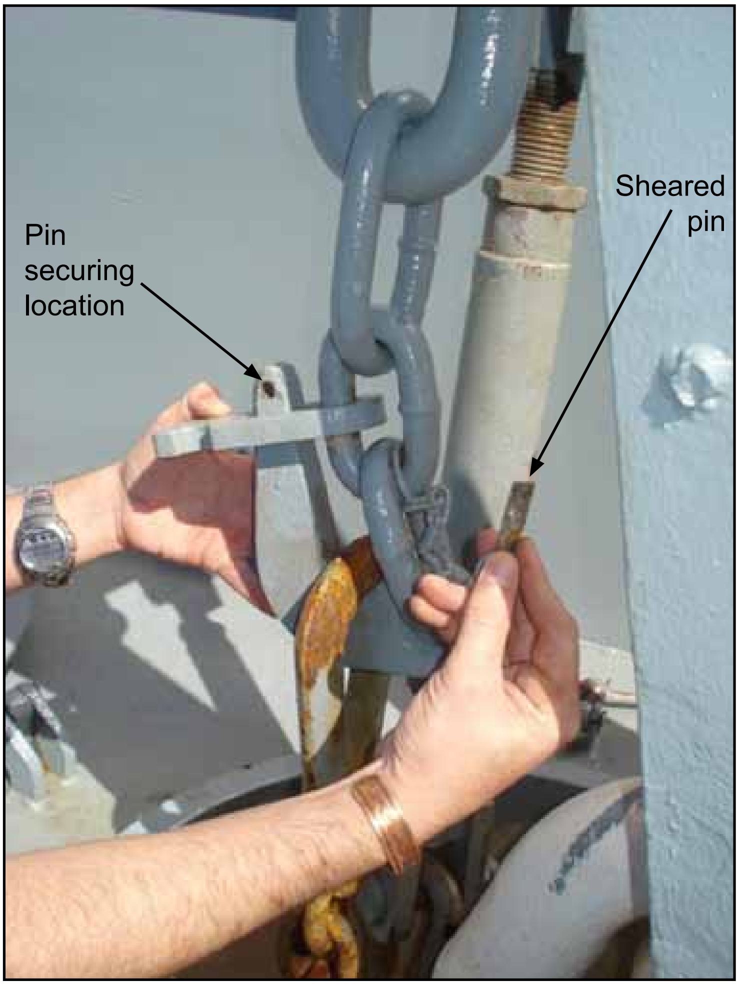
A copy of the Near Miss Report is at **Annex P**.

Figure 28

Maersk Newport's starboard anchor Senhouse slip failed tapered securing pin and replaced arrangement

Image courtesy of Safmarine UK Ltd

Figure 29



Safmarine Nyassa's starboard anchor Senhouse slip sheared tapered securing pin

Image courtesy of Safmarine UK Ltd

Figure 30

Safmarine Nyassa's starboard anchor Senhouse slip sheared tapered securing pin bow shackle replaced arrangement

1.16.3 *Maersk Kithira* – fatality caused by heavy weather (MAIB report 09/2009)

In September 2008, the container ship *Maersk Kithira* was in heavy weather in the South China Sea when the bosun's store bilge alarm sounded. The chief officer and chief engineer went on deck to tighten down a hatch through which the water was entering. They also found the starboard anchor lashing to be loose. While securing the lashing, the chief engineer was swept off his feet by seas being shipped over the forecastle, and he was fatally injured. The investigation found that the heavy weather checklist had been completed but no physical checks had been made on the hatch or anchor security. It was further found that the generic heavy weather checklist had not been modified to include details specific to *Maersk Kithira* as required by the company's instructions.

1.17 SIMILAR ACCIDENTS – FIRES INVOLVING ACETYLENE

There are many examples of acetylene related fires in the workplace ashore as recorded by the Health and Safety Executive. The MAIB's accident database has one recorded similar accident. A fire occurred on an acetylene system on board a dredger following a flashback situation. The ship was at sea and the crew successfully dealt with the fire. Investigations found that the oxygen and acetylene protective flame arrestors and non-return valves had been removed, allowing the flame to travel back to the acetylene regulator, rupturing the hose and causing an external fire.

SECTION 2 - ANALYSIS

2.1 AIM

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

2.2 CAUSE OF HULL DAMAGE

The hull damage, which resulted in the flooding of 5 spaces on 10 November 2008, was due to the widespread impact of the released port anchor on the hull as *Maersk Newport* plunged into the rough seas.

2.3 DISCOVERY AND DAMAGE CONTROL ACTIONS

2.3.1 Discovery

The bosun was the last person to leave the forecastle, at about 0115 on 10 November, having reportedly fully secured both anchors. Because of the heavy weather, the area was not visited again until the bow thruster room fire alarm was investigated, some 12 hours later. During this period the port anchor was released. The forecastle was not visible from the bridge, so the OOW would not have been aware of the release of the anchor. None of the crew heard any impact sound over the noisy weather conditions.

The first positive indication of a problem was when the UMS alarm sounded and a smell of burning was noticed in the ECR. The engineers methodically investigated the possible causes for this. It was not until the bow thruster room fire alarm sounded that the cause of the original UMS alarms was associated with possible water contamination of the electrical systems in the bow thruster room.

The master took appropriate action in providing a safe course so the deck could be safely accessed to enable the alarms to be investigated.

2.3.2 Damage control

Once the flooding situation was confirmed, the crew took effective and positive action to reduce the rate of water ingress to the bow thruster room. Although the water level slowly increased, it was due to a hole that was well below the sea surface, and so was unable to be identified or accessed. The flooding boundary and extent of damage were quickly established, enabling the master to make appropriate judgments regarding safe speed and stability.

2.4 WEATHER, HEAVY WEATHER GUIDANCE, CHECKLIST AND VESSEL SPEED

2.4.1 Weather

It is reported that the weather forecast for 10 November 2008, from SPOS, was for south-westerly force 5 to 6 winds. However, SPOS information for 0000 on 10 November, provided to the MAIB, and which was issued at 1200 on 9 November, forecasted:

- East of Alderney - south-westerly force 8 (35 knots) winds and rain.
- West of Alderney - west-south-westerly force 8 (35 knots) winds and rain.

It was notable that the Solent Coastguard 24 hour Shipping Forecast for Wight, Portland and Plymouth, broadcast at 1130 on 9 November warned of:

"south-westerly force 7 to severe gale 9, increasing to storm force 10 and perhaps violent storm force 11 later"

Despite the forecasts, the weather on sailing from Le Havre was recorded in the Deck Log as south-westerly force 4 to 5 and did not raise any concerns with the master. As a result, no heavy weather precautions were taken even though the weather was set to worsen.

2.4.2 Heavy weather guidance

There was little specific guidance in the GSMS regarding heavy weather issues. Sections 3.16, ID 1377 Speed Reduction **(Annex Q)**, Section 4.6, ID 1387 Navigation in Adverse Weather **(Annex R)**, and Heavy Weather Damage, ID 1148, **(Annex S)** identified the need to reduce speed and alter course in heavy seas or swell to reduce the risk of damaging the vessel and her cargo. In addition, ID1148 included guidance on reporting heavy weather damage. The reference stated that:

"When heavy weather damage is sustained the Master shall report the casualty to Technical Organisation/Management ….."

Item 28 of the Report checklist required confirmation that the Heavy Weather Checklist had been completed and that a copy was to be attached to the report.

It is not possible to specify the exact criteria which influence a master on how to react to a heavy weather situation. Each sea passage is different, and the judgment regarding when to reduce speed and alter course must rest with the master. However, pre-planning for heavy weather is possible, and one of the tools the master has at his disposal is the Heavy Weather Checklist.

To assist the master in this, a Heavy Weather Checklist was included within the SPOS programme. Depending upon the criteria entered into the SPOS a "pop up" would appear reminding the master to carry out the heavy weather checks. There was no evidence that the reminders had been set up.

2.4.3 Heavy weather checklist

There was no GSMS guidance on when the Heavy Weather Checklist was to be used, the judgment being left with the master and chief officer. However, despite the initial force 4 to 5 winds, heavy weather was forecasted and it would have been prudent to carry out the additional checks before the heavy weather was encountered, after which it became too dangerous to access the deck to check doors, hatches and the anchor securing arrangements.

It was noted that the generic Heavy Weather Checklist **(Annex T)** had not been adapted to be ship specific as required by the guidance which was included on the checklist. Masters were also advised in the notes to Technical Flash 08/2007 – Precautions Against Heavy Weather Damage to: “Please discuss the above (heavy weather damage incidents) among the officers and please take this opportunity to make the Heavy Weather Checklist specific to your vessel.” Therefore, even if the list had been used, checks might have been missed which would have been appropriate to *Maersk Newport*. Had the generic list been issued, it is likely that the bosun would have been nominated to check the security of the anchors. It then becomes a matter of opinion as to whether the bosun would have checked these again as he had just reported to the master that the anchors were fully secured shortly after leaving Le Havre.

There are parallels which can be drawn between this accident and the *Maersk Kithira* accident outlined at Section 1.16.3. In both cases, there was not a ship specific heavy weather checklist, and the anchor was not sufficiently secured.

2.4.4 Vessel speed

The master judged that the ship’s motion was satisfactory for him to increase to full sea speed (22 knots) soon after leaving Le Havre. As the seas worsened and movement increased, the speed was reduced to about 15 knots. The master was unaware that the anchor was probably no longer secure, and as the ship’s motion was satisfactory he had no reason to reduce speed further.

Scrutiny of the AIS data between 0900 and 1500 on 10 November 2008, identified 14 vessels that passed through a 25 mile radius set around *Maersk Newport’*s 1212 position – about 1 hour before the UMS alarm sounded. Details of the speed ranges and the number of vessels within those speed ranges are at Table 4.

Speed range in knots	Number of vessels in speed range
7 -10	3
10 - 15	5
15 – 20.5	6

Table 4 – Speed ranges and number of vessels in the ranges between 0900 - 1500 on 10 November 2008

Of the 6 vessels in the 15-20.5 knot range, 5 were container ships, 3 of which were proceeding in excess of 20 knots. The remaining vessel in the speed range was a refrigerated cargo ship. This suggests that *Maersk Newport*'s speed was not excessively high compared with similar ships passing through the area in the prevailing weather conditions.

However, the ship's pitching motion would have contributed to lowering of the anchor as the securing arrangements progressively failed.

2.5 CAUSE OF THE FAILURE OF THE PORT ANCHOR SECURING ARRANGEMENTS

2.5.1 General

While the anchors were in their stowed positions, the primary securing device was the chain lashing which was adjusted by the bottle screw to ensure that the anchor was "hard up". The secondary device was the large band brake which was capable of holding the anchor securely in the event that the chain lashing failed.

There was a misconception that the guillotine blocks formed a designed part of the securing arrangement while at sea. This was not the case. The blocks were used to take the weight off the winch when the vessel was at anchor. If the face of a link was forced hard up against the face of the guillotine blocks, when at sea, this could have prevented the blocks from being lifted, should the anchor have been required to have been released in an emergency.

2.5.2 Chain lashing design issues

The chain lashing needed to be tight to prevent inadvertent release of the Senhouse slip. An additional safety barrier was provided by the tapered pin, which when driven fully home should have prevented the Senhouse slip opening.

If the pin was not driven home for its full length, or if it was contaminated, e.g. by paint, it could have become displaced through vibration, enabling the slip and the chain lashing to be released.

The Senhouse slip arrangement, and its securing pin, was manufactured in accordance with the German Normenstelle Schiffs-und Meerestechnik standard - VG 84504-1. The German organisation which sets the standard is equivalent to the British Standards Institute. However, investigation has found that there is no equivalent British Standard for the Senhouse slip arrangement. A British company does make Senhouse slips for the Royal Navy, but to an Admiralty Pattern. In this case, the securing pin used is a parallel pin which is moused to improve security.

The system operating manual does not indicate any need to improve the tapered pin security. However, mousing the pin or, alternatively, replacing it with a drop-nose pin or securing it with a split pin or similar system, would help to ensure security should the chain lashing not be properly adjusted.

It is noted that the starboard anchor Senhouse slip pin had failed some time earlier and that *Safmarine Nyassa* had also suffered a similar failure (Section 1.16).

The technical department has, since, advised *Maersk Newport, Maersk Norfolk* and *Maersk Newbury* to modify the tapered pin by drilling a hole at one end to accommodate a split pin or a lynch pin. Although there are a number of other A.P. Møller Maersk ships fitted with the same arrangement they have not been included in the instruction.

2.5.3 Winch band brake

While the manually tightened band brake should be capable of holding the anchor, its effectiveness is dependent upon the strength of the individual applying the brake. The brake system did not have any alignment marks to indicate that it was fully applied. Indeed this would have been inappropriate because as the brake lining wears, alignment of any original marks would mean that the brake would not be fully applied, increasing the likelihood of failure.

An extended wheel spanner is often used to increase leverage and to ensure that the brake is fully tightened. However, there should be no need for this arrangement as the 500N force required to fully apply the brake is well within the capability of an able bodied person.

2.5.4 Inspection

Apart from the nut and bolt on the starboard Senhouse slip in place of a securing pin, no defects were found with the system. Although the band brake lining could not be completely examined without dismantling it, the outer edges were free of oil and grease, which might have affected its holding power. There was no apparent mechanical reason why the band brake should have rendered.

2.5.5 Failure mode

When the bosun secured the anchors on the ship leaving Le Havre, he was confident that the chain lashings were properly applied and that the band brakes were fully tightened. However, the bosun was of small stature and it is quite possible that another individual might have been able to tighten the brake much further.

The guillotine blocks were lowered and rested on the cable in accordance with the operating instructions. Neither the hawse pipe covers nor the spurling pipe covers were fitted.

As the vessel pitched into the rough seas, vibration would have been set up. Because the hawse pipe covers were not fitted, water would have been forced up the hawse pipe, accentuating the effects of the vibration. This would have adversely affected the security of the tapered pin because it was only fitted by hand. The pin would have fallen out, releasing the slip and the chain lashing. As the ship pitched, the acceleration forces would have increased and overcome the rendering force applied by the brake, which could not have been fully tightened. As the anchor cable shifted in the hawse pipe, this would have caused the pivoted guillotine blocks to bounce to the upright position. The port anchor cable would then have been free to progressively drop as the pitching motion continued.

2.6 VOYAGE DATA RECORDER

The VDR has become an invaluable tool to the marine accident investigator and to ships' owners. It provides evidence on a wide range of recorded data dependent upon the type of unit fitted.

However, the information will only prove useful if the crew are familiar with, and are aware of the occasions on which the "save" function should be used. In this case the crew had little knowledge of the "save" procedure or that the system overwrote the memory on a 12 hour rolling basis. The master did not use the "save" function following the discovery of the heavy weather damage and the technical department did not instruct him to do so, despite being alerted to the accident.

One of the DPA's first actions on being told of an accident should have been to instruct the master to save the VDR data to assist with his investigation. Because he was not aware of the accident the instruction was not given and so the last opportunity to save the evidence was lost.

The GSMS discusses the need for masters and watchkeeping officers to be aware of the features of VDRs fitted to their particular ships, but it provides no instruction on when the information should be saved.

2.7 FIRE ANALYSIS

2.7.1 General

Because neither the heavy weather damage nor the fire accidents were reported to the MAIB there was a delay in conducting the investigations. This was particularly relevant in the case of the fire because much of the fire site evidence was lost by the time it could be visited by MAIB inspectors.

Importantly, the electrician/safety watchman left the forecastle at about 0100, so no one witnessed the source of ignition or the initial development of the fire. It was not until about 0110 that the foreman noticed sparks, probably coming from the burning mooring rope, which alerted him to the fire, that had by now probably been burning for some 10 minutes.

While the cause of the fire is a matter of speculation a number of fire development scenarios were considered as discussed below.

2.7.2 Flashback from the burning equipment

At 0055 the burning equipment operators shut off their blowtorches, and up to that point the equipment had been operating normally. Had a flashback occurred, which initiated the fire, the flame would have had to travel past the flame arrestor at the blowtorch acetylene hose connection and up the acetylene hose. However, the electrician/safety watchman was on the forecastle at that time and did not see anything untoward. The flame arrestors and non-return valves were also found to be fully functional and in good condition, and compliant with the European Norm standards. This was also confirmed during Air Liquide's inspection of the equipment on 19 November 2008 **(Annex F)**.

Importantly, there was no evidence of carbon deposits inside the acetylene hose which would be expected in a case of a flashback.

This cause can be discounted.

2.7.3 Mishandling of the acetylene bottles

If acetylene bottles are dropped, there is a risk that the acetylene will decompose into its constituent parts of carbon and hydrogen, and so cause an explosion. This is typically preceded by the bottles vibrating and heating up. In this case the bottles had been on board for about 24 hours prior to use and there were no indications of them being mishandled.

Although two of the acetylene bottles exploded, the first did so after the fire had started, as evidenced by the terminal security camera recording. This confirms that the fire caused the explosions, and not vice versa.

2.7.4 Risk from acetylides

Under certain conditions acetylene can react with copper, silver and mercury to form explosive acetylides which can be detonated by heat, friction or shock. There is no evidence that these materials were in contact with the acetylene gas and, once again, the explosion was subsequent to the discovery of the fire. It is therefore concluded that explosive acetylides were not the cause of the fire.

2.7.5 Acetylene gas leak

It is known that the contractors did not carry out leak tests on any of the three acetylene or three oxygen connections to the bottle regulators. It is possible that a gas leak might have occurred on a connection at some point following the start of work at about 2045.

Acetylene is slightly less dense than air, and mixes readily with it. The explosive limits for the acetylene/air mix are between 2.4 – 83% and the mixture is easily ignitable. There was a fairly strong breeze across the deck throughout the evening, and it is likely that any acetylene leakage would have dissipated fairly quickly had the area been completely open.

However, the forecastle bulwark was high and there were many obstructions on the deck. Although very remote, it is possible that gas pockets could have accumulated, ignited and tracked back to the leaking bottle, causing the fire to spread to other bottles, hoses and the mooring ropes.

2.7.6 Clothing near to the acetylene storage area and mooring rope

A strong possibility for the cause of the fire is that the clothing in the vicinity of the gas bottles was ignited which, in turn, caused the fire to escalate to the acetylene hoses and mooring rope.

2.8 IGNITION SOURCES

2.8.1 Electrical

The contractor's electrical equipment was in good condition, it was certified to be intrinsically safe and there was no evidence of electrical short circuits which could cause sparks.

The mooring winches were in auto-tension at the time of the fire, so the electrical circuits were live and contactors were opening and closing. The covers of all the contact and junction boxes were removed but there was no evidence of short circuits or earth conditions which could give rise to sparks. Ignition of an acetylene/air mix or of the clothing from electrical equipment can be discounted.

2.8.2 Other hot work on deck

Neither the ship's staff nor contractors carried out any form of hot work, such as grinding, on the forecastle deck prior to the fire. This discounts the possibility of sparks causing smouldering and subsequent ignition of either the clothing or the mooring rope.

2.8.3 Repair work

The insert plate burning procedures would have produced hot work slag, some of which would have been ejected overboard. The slag was too dense to have been picked up by the wind and would have dropped directly into the water.

The grinding out of the insert plate holes would have produced sparks, and again some would have gone overboard and travelled a short distance in the wind before they rapidly cooled down. Although this source of ignition cannot be entirely discounted, it is most unlikely because of the distances involved and the rapid cooling of sparks generated by grinding.

2.8.4 Discarded cigarette

The electrician/safety watchman was a non-smoker but three of the other contractors were smokers. The clothing and food found in the immediate vicinity of the origin of the fire suggests that the area was used as a work break area and smoking could have taken place there. However, there is no evidence to confirm that any of the contractors had smoked in the area.

While the electrician/safety watchman was unsure if the four stevedores he saw were smoking or not, a discarded cigarette could easily have initiated smouldering and ignited the dry clothing over a relatively short time. The possibly of a discarded cigarette igniting a pocket of acetylene/air mixture cannot be entirely discounted but is considered far less likely because of the likely dissipation of any gas leakage.

2.8.5 Static electricity

The dangers of polypropylene generated static electricity as a source of ignition of gaseous or dust laden atmospheres are well known. What is less clear is whether a polypropylene mooring rope, in auto tension mode, is capable of generating and discharging an incendive spark of sufficient strength to ignite an acetylene/air mixture within its explosive range.

The results of the independent tests discussed at Section 1.15 concluded that, when the mooring rope was subjected to an externally induced electrical charge, it degraded very quickly across a range of ambient temperatures and relative humidities. There is no evidence to support the possibility that a static charge, of sufficient strength to cause an incendive spark, could have been built up in the mooring rope, while in the auto tension mode. Consequently, this source of ignition has been discounted.

2.8.6 Conclusion

It is concluded that the most probable cause of the fire was a discarded cigarette. It is likely that this caused smouldering, which was fanned by the strong breeze and then ignited the clothing near to the port windlass winch polypropylene mooring rope and the acetylene hose leading to the bow thruster compartment. The clothing probably either ignited the mooring rope, which in turn burnt through the acetylene hose, causing the acetylene/air mix to ignite, or the burning clothing burnt through the acetylene hose, which then ignited the mooring rope.

In either case, the fire would have quickly and easily spread to the acetylene bottle storage area. The adjacent open acetylene supply hose to the forepeak would have quickly burnt through, allowing acetylene to escape and ignite. As the fire intensified, the pressure in the acetylene bottles would have increased, causing two of them to explode and many others to distort and split. The radiated heat was able to easily transfer the short distance to the oxygen bottle stowage causing one of the bottles to explode. It is known that at least one of the acetylene bottles was found lying on the deck. This would have caused the acetone in which the acetylene was dissolved to "pool" on the deck and ignite, adding to the intensity of the fire and so causing the deck plate distortion.

2.9 FIRE-FIGHTING ACTIONS

This accident shows the benefits of conducting fire-fighting drills so that in the case of a real fire reactions are instinctive and safe. The crew reacted promptly to the general alarm and set about tackling the fires from a position of refuge behind the breakwater bulkhead. The mooring rope fire was quickly extinguished, and there is no doubt that the priority given to cooling the acetylene bottles reduced the risk of more of them exploding, with further resultant damage.

The contractor's Burner who exited the bow thruster compartment is commended for his quick thinking in trying to shut off the acetylene bottle valves despite the intense heat. His subsequent attempt to fight the fire using one of the ship's fire-fighting hoses was also commendable. Unfortunately, this was unsuccessful because the ship operated a dry fire main system, which meant that the system was not constantly pressurised.

2.10 HOT WORK PROCEDURES

Careful and strict control of hot work is necessary to prevent the risk of fires breaking out in the work area, adjacent compartments, cargo containers and in ventilation and flammable systems.

2.10.1 Algeciras Port Authority

The APA approved the hot work on the basis of the information provided by the agent. However, the agent omitted to include details of the DG carried by the ship, so approval was given without the full knowledge of the risks.

The written approval, in Spanish, was granted and delivered to the ship and to the contractors. However, despite no one on board being able to read Spanish, there was no attempt to translate the document to check if there were any conditions with which the ship needed to comply.

Importantly, the first paragraph of the approval stated that:

> "*….the works are carried out in compliance with the Ship Management Procedures (S.G.S) and under the control and supervision of the Captain".*

In this case, S.G.S. were the procedures laid out in the GSMS.

2.11 ONBOARD HOT WORK AND PERMIT TO WORK

The onboard hot work and PTW procedures were not followed. No risk assessment was undertaken, and no briefing was given to the contractors by the chief engineer, as required by the GSMS **(Annex K)**, of the procedures to be followed.

The original plan was that hot work was not due to start until the vessel returned to the lay-by berth, so the ship's staff had no reason to invoke the control procedures at the container berth. However, the plan was changed, as agreed between the contractor and the technical superintendent, for hot work to start at the cargo terminal. While the crew were aware that preparatory work would continue at the container berth, they were unaware of the intention to carry out hot work.

The fire/smoke detector fitted in the bow thruster room was isolated following the flood damage. A replacement was awaiting delivery. Had this been operational, it would have alerted the crew to the hot work. Had they been aware of the hot work intention in the first place then it is likely that the additional checks detailed in the GSMS would have been made. At the very least the crew would have been aware of the increased dangers and more frequent checks of the work area could have been made.

2.12 CONTRACTOR'S PROCEDURES

The repair contractor was well known to the APA and to A.P. Møller Maersk and was considered to be conscientious and reliable. Maersk had used the contractor on many occasions for repair work. Despite this, the contractor did not comply with all the conditions of the harbour authority's approval for hot work or to the conventions of good practice when using oxy/acetylene.

2.12.1 Approval for contractor's hot work

The APA's approval for hot work was specifically conditional upon compliance with the master's Safety Management System. This meant compliance with the onboard hot work PTW procedures. The technical superintendent was closely involved with the contractor throughout. Because he was aware of the intended hot work, and did not mention to the contractor the need for any other approval, the work went ahead without the appropriate control measures in place.

2.12.2 Communications and electrician/safety watchman

The APA's hot work approval required that:

"… there must be a permanent watchman with VHF"

The electrician/safety watchman left his station at the critical time of about 0100, without the knowledge of the foreman and just before the fire started. Had he been in his designated position, or relieved by another person, then the initiation of the fire would probably have been seen and prompt action could have been taken to prevent escalation. As it was, the fire developed over about 10 minutes before any action was taken.

The only method of communication among the contractors was by mobile telephone. Had VHF radios had been available, then at least the Foreman could have contacted the ship's staff to raise the alarm as soon as he detected the fire.

2.12.3 Location of oxy/acetylene bottles

The "in use" acetylene bottles are at most risk from a flashback situation. This can cause the hose to rupture and a fire to develop. The situation is exacerbated, as in this case, if those bottles are co-located with others in a storage area, enabling the fire to spread rapidly to other bottles.

Established best practice is to remove and secure the "in use" bottles away from the storage area and so reduce the risk. Had this been done in this case, the spread of the fire would have been reduced.

2.12.4 Leak tests

Acetylene gas leaks are most likely to occur at the hose connections to the blowtorch and regulator, so it is important that leak tests are carried out.

The contractors did not routinely carry out a leak test, relying rather on the experience of the workers to hear, or smell, any acetylene gas passing into the atmosphere. A simple leak test, using a propriety testing agent, would have quickly identified any problems which required action to reduce the risk of fire or explosion.

2.13 COMMUNICATION ISSUES

Clear, unambiguous communications are the catalyst for ensuring that those involved in an activity fully understand the requirements and implications. Effective communications would have allowed safe working practices and control measures to be put in place to reduce risks.

It is apparent that poor communication was a recurring factor in both accidents.

2.13.1 Communications with the DPA

On discovering the heavy weather damage the master notified the technical superintendent and the DPA of the problems by e-mail attachment. However, the attachment could not be opened because of the file extension used, so it was resent, but only to the technical superintendent.

Although the requirement to inform the DPA is clearly stated in the GSMS, there was no further communication with him, either by the Casualty Committee, master or technical superintendent. This meant that the DPA was unable to fulfil his obligation to investigate accidents as laid out in his role description, namely to:

> *"Lead the evaluation of safety reports and the investigation of accidents"*

This resulted in the VDR recordings being overwritten because the DPA did not have the opportunity to instruct the master to save the information as would have been his normal course of action. This denied MAIB inspectors the opportunity to use the information that would have been recorded.

Following the heavy weather damage report the Casualty Committee was convened at Maersk's headquarters in Copenhagen. The GSMS procedures stated that the managing director of MMS can be called upon to contribute to the discussions where appropriate. However, despite conferencing facilities being available, he was not included in the discussions, so he was unaware that there was a problem. As a result, the DPA remained unaware of the accidents despite having a clear responsibility for the ship.

After the fire happened on 15 November 2008 the accident reporting process once again failed. Maersk headquarters was informed, as was the WOC, but the DPA was not.

2.13.2 Communications between the technical superintendent, contractor and ship's staff

The technical superintendent's communications with the repair contractor were good. Both understood the scope of work and timescales involved.

However, the ship's staff seemed reluctant to interact with the contractor because the technical superintendent was in charge of the repair. While the technical superintendent was aware of the hot work situation the ship's staff were not.

In this case, the risk of fire in adjacent compartments or systems was slight. However, in different circumstances flammable systems could have been involved, with far greater consequences. It is essential that the ship's staff impose their control measures to ensure that systems are correctly isolated and so prevent an inadvertent fuel source being ignited by hot work processes. In this case, the master was not able to fulfil his prime responsibility of maintaining the safety of his ship by exercising oversight of all the activities on board.

Although the APA gave permission for the hot work, this was in Spanish. None of the crew of *Maersk Newport* spoke Spanish and no effort was made to get the permission translated, so the ship's staff was unaware if there were any particular conditions which needed to be complied with.

2.13.3 Accident reporting

The heavy weather damage and fire accidents were not reported to the MAIB as required by regulations and as laid out in the GSMS, Section 7.1.7 of the Technical Casualty Manual for Technical Organisation – ID 1183, dated 1 July 2008 **(Annex L)**. Despite the Casualty Committee involvement it was not until 19 November 2008 that the MAIB first became aware of the accidents and informed the DPA, who was still unaware of them up to that point.

The delay impacted on the ability to examine the fire site immediately after the fire and to test a number of hypotheses with the equipment still in place.

2.13.4 Common defect reporting to the A.P. Møller Maersk fleet

Section 1.16.2 of this report highlights that *Safmarine Nyassa,* part of the A.P. Møller Maersk fleet, also suffered a failure of the anchor securing system. The arrangements were identical to those fitted to *Maersk Newport.* However, this was considered to be an isolated case and so the rest of the A.P. Møller Maersk fleet were not informed of the failure. During the course of the investigation it was noted that there was an apparent reluctance to share information between the independent business sections. While the need to maintain a competitive edge is understood there should be no barriers to the sharing of safety related information. Had this information been shared, it is possible that the other affected ships would have taken measures to improve the securing system and so prevent the heavy weather damage which ultimately led to the fire and 8 days loss of service.

2.14 GSMS

Although there were some minor omissions, e.g. VDR "save " procedures, the GSMS was found to be a comprehensive document. The continual review and auditing by sea going staffs, as well as shore management, was well structured and helped ensure that the document remained current. Crew reported that the training programme was effective but that navigating around the system was not always intuitive.

While the GSMS instructions covered all areas associated with the accidents, the application of those instructions, i.e. PTW procedures and Induction Programme for Contractor's Employees, was not carried out because the ship's staff were unaware that hot work was planned at the container berth.

2.15 FATIGUE

The master and bosun averaged 14 and 12 hours rest per day respectively, during the 4 days leading up to the heavy weather damage on 10 November 2008.

The crew worked a daytime routine for the 24 hours preceding the fire on 15 November 2008.

Those involved in activities related to the accidents were well rested and fatigue is not considered to be a factor in either case.

SECTION 3 - CONCLUSIONS

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

1. Evidence indicates that the chain lashing was not properly tightened and the winch brake was not fully applied. When the chain lashing released the brake failed to hold the anchor. [2.5.2], [2.5.3], [2.5.4], [2.5.5]

2. The port and starboard hawse pipe covers had not been fitted on the ship leaving Le Havre. This would have increased the risk of displacing the Senhouse slip securing pin through water impact and vibration. [2.5.5]

3. Instructions to modify the securing arrangement for the Senhouse slip tapered pin have been sent by the technical department to three of the affected "N" Class vessels but not to other A.P. Møller Maersk ships which have the same arrangement. [2.5.2]

4. No heavy weather precautions were taken, although the weather conditions were set to worsen. There was no specific guidance in GSMS as to when the Heavy Weather Checklist was to be used, the judgment was left to the master and chief officer. [2.4.1], [2.4.2], [2.4.3]

5. The generic Heavy Weather Checklist had not been adapted to be ship specific as required by the instruction on the checklist. There was a risk that even if the generic checklist had been issued, the checks would have been incomplete. [2.4.3]

6. Although highly unlikely, it is possible that the fire was ignited by sparks produced from grinding. However, the fire was probably initiated by a discarded cigarette. [2.8.3], [2.8.4]

7. Flammable clothing was left in the vicinity of the acetylene gas bottles. There is a strong possibility that this ignited and caused the fire to escalate. [2.7.6], [2.8.4], [2.8.6]

8. No gas leak tests were carried out by the contractor to ensure the integrity of the system. It is possible that gas pockets could have accumulated and tracked back to a leaking connection. [2.7.5], [2.12.4]

9. The "in use" bottles were co-located with the storage bottles, increasing the risk of spreading the fire. [2.12.3]

10. APA's instructions that hot work approval was conditional on compliance with the ship's safety management system were not followed. [2.10.1], [2.12.1]

11. Poor communications between the technical management and the ship resulted in confusion regarding hot work arrangements and impacted on the master's ability to discharge his safety responsibilities. [2.13.2], [2.11]

12. The APA's hot work approval was in the Spanish language and could not be understood by the crew. [2.10.1], [2.13.2]

13. The contractor's electrician/safety watchman was not equipped with a VHF radio. He left his station without advising the foreman, so no one witnessed the fire development and no action was taken for about 10 minutes. [2.7.1], [2.12.2]

14. The VDR information was not saved. The GSMS did not specify the occasions when the "save" function was to be used, so there was a high risk of losing important accident data. [2.6], [2.13.1]

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

1. Neither of the accidents was reported to the MAIB or to the DPA as required by regulations and the GSMS instructions. This impacted on the ability to scrutinise the fire scene and to test hypotheses at an early stage. [2.7.1], [2.13.1], [2.13.3]

2. The Casualty Committee did not include the MMS managing director or the DPA in discussions following the heavy weather accident, so they were unaware of the situation. [2.13.1]

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

1. The design of the anchor chain lashing Senhouse slip tapered securing pin makes it susceptible to displacement by vibration, if it is not driven fully home and the chain lashing properly tightened. [2.5.2]

2. *Maersk Newport*'s starboard anchor lashing Senhouse slip securing pin had sheared prior to the heavy weather accident involving the port system. *Safmarine Nyassa* had also suffered a similar failure, but this information had not been promulgated fleetwide. [2.5.2], [2.13.4]

3. Details of dangerous goods were not included in the application form submitted by the Maersk agent in Algeciras for hot work approval by the APA. The approval was given without full knowledge of the facts. [2.10.1]

SECTION 4 - ACTION TAKEN

4.1 A.P. MØLLER MAERSK

On 24 November 2008 the Technical Vessel Operations Container Fleet Group Manager sent an e-mail advising *Maersk Newport, Maersk Norfolk* and *Maersk Newbury* of the heavy weather accident **(Annex U)**. The communication instructed that the Senhouse slip securing pin was to be modified to incorporate a split pin to improve its security.

On 2 January 2009 Technical Flash 04/2009 – Loss of Anchors **(Annex V)** was issued to the A.P Møller Maersk fleet. Ships were instructed to:

- Ensure that instructions on how to adjust windlass brakes were held on board.
- Carry out a systematic check to ensure that all security pins were available and were in good order.

4.2 MAERSK MARINE SERVICES LIMITED

Immediately after being made aware of the accidents, the DPA advised *Maersk Newport*'s master of the correct reporting procedures on informing the MAIB and DPA of accidents.

4.3 MAERSK AGENT ALGECIRAS

Following the fire on 15 November 2008 the Maersk agent in Algeciras has:

- Reviewed its procedures to ensure that details of DG are included in requests for hot work for approval by the APA.
- Made arrangements for an English translation of the APA's Spanish language hot work approval to be delivered to the subject vessel.

SECTION 5 – RECOMMENDATIONS

A.P. Møller Maersk is recommended to:

2009/130 Review and amend its current procedures to ensure:

- Casualty Committee composition is appropriate to the specific circumstances.
- Compliance with the accident reporting requirements for United Kingdom registered vessels.
- Effective and inclusive communications between shore management, contractors and ship's staff.
- All identified safety related deficiencies are sufficiently assessed for fleet wide notification.
- Ship's staff, regardless of management involvement, maintains oversight of contractors and that the hot work Permit to Work procedures, as specified in the Global Ship Management System, are strictly complied with.
- Foreign language work approvals are translated for compliance purposes.
- Global Ship Management System includes detailed instructions for the preservation of Voyage Data Recorder information for accident investigation purposes.

Servyman del Estrechio S.L. is recommended to:

2009/131 Review hot work procedures to ensure that:

- Workers are equipped with a VHF radio to communicate with each other and the crew in an emergency.
- A nominated safety watchman is always readily available and that a replacement is allocated during his/her absence.

2009/132 Adopt industry best practice by:

- Carrying out leak tests on newly assembled oxy/acetylene connections.
- Separating "in use" gas bottles from those in the storage area where this is feasible.
- Ensuring that no flammable materials, including clothing, are left in the vicinity of oxygen/acetylene bottles.

Marine Accident Investigation Branch
June 2009

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