Report on the investigation into the fatal

accident to the chief engineer in the lift shaft on board

Ever Excel

in Kaohsiung, Taiwan

on 21 April 2010

Marine Accident Investigation Branch
Mountbatten House
Grosvenor Square
Southampton
United Kingdom
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Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

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

NOTE

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

Front cover image courtesy of Pete via Wikimedia Commons.
(Photographed under vessel's previous name)

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ABS	:	American Bureau of Shipping
ATSB	:	Australian Transport Safety Bureau
cm	:	centimetre
COSWP	:	Code of Safe Working Practices for Merchant Seamen
DOC	:	Document of Compliance (ISM Code)
EMU	:	Evergreen Marine (UK) Limited
EPA	:	Environmental Protection Agency (USA)
HSQEMS	:	Health, safety, quality and environment management system
IMO	:	International Maritime Organization
ISM Code	:	International Safety Management Code
ISO	:	International Organization for Standardization
kg	:	kilogram
KPI	:	Key Performance Indicator
kW	:	kilowatt
LOLER	:	Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment)(LOLER) Regulations 2006
m	:	metre
MCA	:	Maritime and Coastguard Agency
MGN	:	Marine Guidance Note (MCA)
P&I	:	Protection and Indemnity (Club)
SMC	:	Safety Management Certificate (ISM)
SOP	:	Standard Operating Procedures
STCW	:	The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended
TEU	:	Twenty Foot Equivalent (container) Units

UMS : Unmanned Machinery Space

VGP : Vessel General Permit – US environmental legislation

VMPS : Vessel Maintenance Planning System

Times: All times used in this report are in Taiwanese Local Time (UTC+8 hours)

SYNOPSIS

On 21 April 2010 the chief engineer on board the UK registered container ship *Ever Excel* was killed when he became trapped between the top of the ship's passenger lift and the edge of the lift shaft.

Ever Excel was alongside in Kaohsiung, Taiwan, undergoing a preliminary environmental compliance inspection, which required that the pit of the lift shaft be checked for oil residues. The second engineer was unable to open the lift shaft doors to gain access to the lift pit and the chief engineer intervened to resolve the problem. Without stating his intentions, the chief engineer entered the lift car, climbed through an escape hatch to reach the top of the lift car, and closed the hatch behind him.

The second engineer reset the lift controls, incorrectly assuming that the chief engineer had taken manual control of the lift from on top of the lift car. The chief engineer had not, and the lift was returned to its normal automatic operating mode. The lift moved upwards at its usual operating speed and trapped the chief engineer against the door sill of the deck above, asphyxiating him. It is not known exactly what the chief engineer intended to do, but it is likely that he was looking at the back of the lift shaft doors to establish how the locking mechanism worked.

The investigation found that all the safety barriers that could have prevented the accident had been ignored, reset, or circumvented. The risks associated with lift maintenance and inspection had not been considered.

This was the third fatal accident in an 8-month period on board ships operated by Evergreen Marine UK Limited (EMU). One crewman was killed on *Ever Elite* and another on board *Ever Smile* in occupational accidents. EMU sent specific instructions and procedures to the ships immediately following the accidents; however, the underlying safety issues were not addressed.

The investigation found that, although EMU's safety management system was compliant with the international standard, there were serious failings in its implementation. Few risk assessments were completed, safe systems of work had not been established and work permits were not used appropriately. Communication between crew and shore management was ineffective, and underlying problems were not identified.

The MCA has assisted EMU in developing its system of risk assessment and operating procedures. EMU has subsequently developed additional training in safety awareness and lift maintenance, and has sent further instructions to its ships on safe working.

A recommendation has been made to the highest levels of EMU's management to recommit to establishing a "just safety culture" within a robust safety management system.

Image courtesy of Pete via Wikimedia Commons.

Ever Excel - photographed under previous name of *Hatsu Excel*

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *EVER EXCEL* AND ACCIDENT

Vessel details

Registered owner	:	MCC Leasing (No.24) Limited
Manager(s)	:	Evergreen Marine (UK) Limited
Port of registry	:	London
Flag	:	British
Type	:	Container ship
Built	:	2002 in Japan by Mitsubishi Heavy Industries, Ltd.
Classification society	:	American Bureau of Shipping (ABS)
Construction	:	Steel
IMO number		9241322
Length overall	:	299.99m
Gross tonnage	:	76,067
Engine power and type	:	48,600kW Mitsubishi Sulzer 12RTA84C-UG
Service speed	:	24.5 knots
Maximum TEU capacity	:	6,332
Lift Manufacturer and type		Schindler Elevator KK. Single wrap traction geared.

Accident details

Category	:	Very serious marine casualty
Time and date	:	1100 on 21 April 2010
Location of incident	:	Kaohsiung, Taiwan
Persons on board	:	17 crewmen and two company shore-based engineers
Injuries/fatalities	:	Chief engineer, Mr Lii Ming, crushed and asphyxiated by the passenger lift

1.2 BACKGROUND

Ever Excel's crew were preparing for an inspection by the US Government's Environmental Protection Agency (EPA), which was expected to occur when the vessel called into a US port during the next voyage. Inspection of all the potential discharges from the ship, that might cause adverse environmental impacts, was required in order to gain a Vessel General Permit (VGP) under the US Clean Water Act.

A preliminary in-house inspection by Evergreen Marine (UK) Limited's (EMU) environmental engineer was to be carried out, with assistance from the ship's engineering officers, while the vessel was alongside in Kaohsiung, Taiwan. The procedure whereby a VGP was gained required 26 potential effluent sources to be checked. It included, among other items such as deck run off and ballast water arrangements, that the pit at the bottom of the lift shaft be checked to establish if it contained any effluent.

1.2.1 Background to the investigation

In September 2009 a crewman died when the accommodation ladder he was rigging on *Ever Elite* descended uncontrollably, taking him overboard. Two months later, a crewman on the aft mooring deck of *Ever Smile* died when a tug's messenger line wrapped around one of his legs and pulled him overboard. The accident on *Ever Excel* was the third work-related fatal accident in the 11 ship EMU fleet within an 8 month period. In context, a total of 5 fatal accidents occurred in the UK registered fleet of 815 ships[1] in the year from 1 June 2009 to 1 June 2010.

1.3 NARRATIVE

1.3.1 Arrival at Kaohsiung

At 0454 on 20 April 2010 *Ever Excel* anchored in Kaohsiung's port approaches to await an available berth. During the day, the master received an email from the company's environmental engineer with a proposed schedule for the preliminary VGP inspection to be held the following day.

Ever Excel departed the anchorage at 0215 on 21 April and, at 0512, berthed alongside in Kaohsiung. Container discharge started soon afterwards.

1.3.2 Pre-accident narrative

At 0600 the company's port engineer joined the ship to assist the ship's engineers with planned maintenance of a main engine cylinder unit and a turbo charger. A sludge barge berthed alongside shortly afterwards to remove the ship's waste oil.

Soon after 0600 the master went ashore for the day for compassionate reasons. At around the same time, the chief engineer's wife arrived on board to visit him; he had been on board for 11 months.

[1] SOLAS vessels (greater than 500GRT)

At 0930 the company's environmental engineer embarked, and at around 0950 he had a brief discussion with the chief engineer about the schedule for conducting the preliminary VGP inspection. There was no discussion about accessing machinery or safe methods of working. The inspection started in the main engine room with the two men checking the oily water separator operation, alarms, and discharge arrangements. The chief engineer used a camera to record the inspection's findings. The environmental engineer then went to meet the second engineer at the lift.

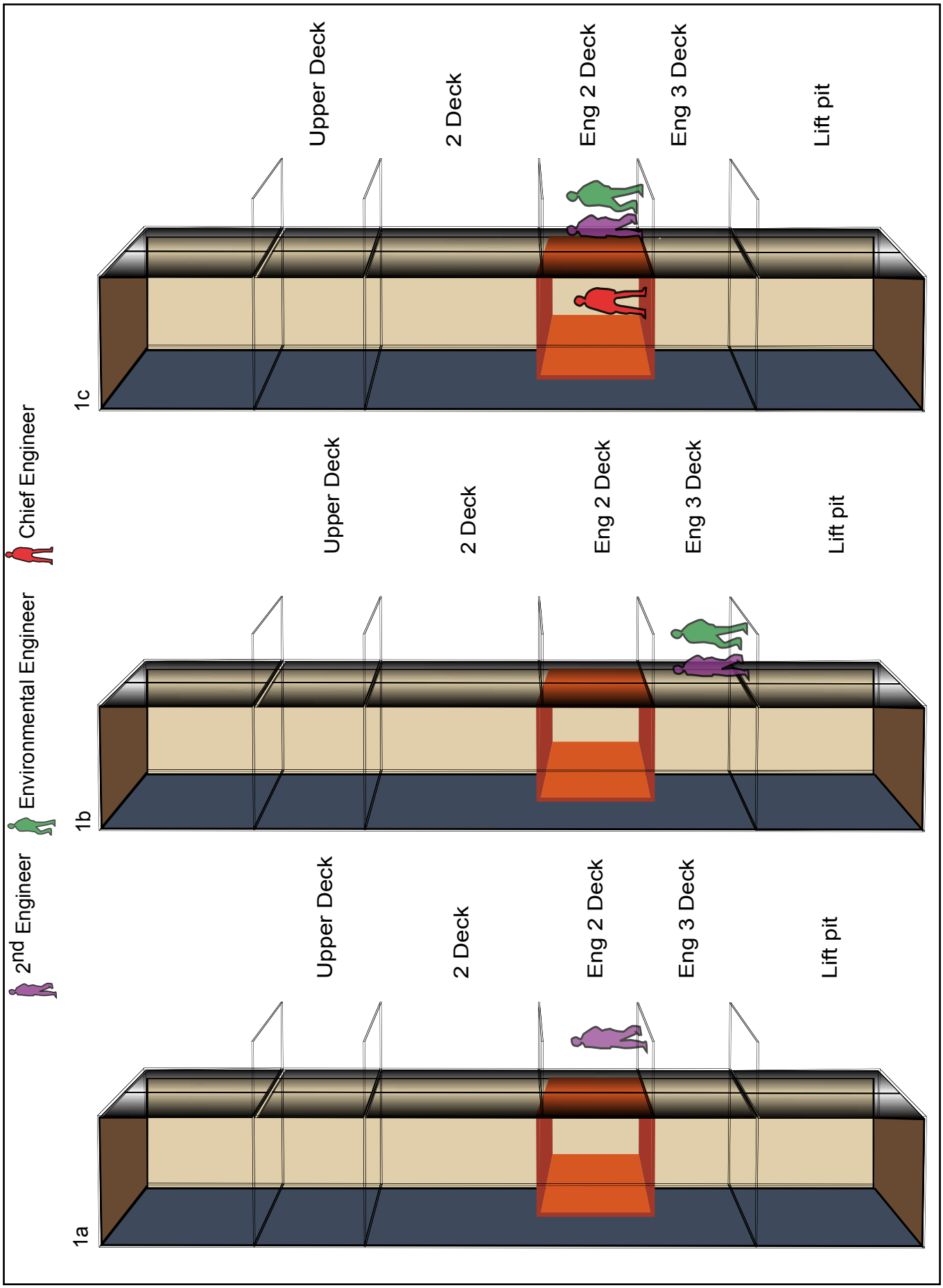
At around 1020 the chief engineer went to his cabin, where his wife was waiting. Shortly afterwards, he received a telephone call from the environmental engineer, who asked the chief engineer to bring his camera so that he could take some pictures of the lift pit during the inspection. The chief engineer then left his cabin, taking his camera with him.

At about 1050 the second engineer called the lift to the engine room 2nd deck and entered the lift car **(Figure 1a)**. He pushed the emergency stop button and opened the emergency escape hatch to activate safety interlocks and stop the lift car from moving automatically if it was called. The second engineer then went down to the engine room 3rd deck and met the environmental engineer with the intention of opening the lift shaft doors and checking for oil residues in the lift pit immediately below **(Figure 1b)**.

The second engineer attempted to use the access key **(Figure 2a)** to disconnect the lift shaft doors from the locking mechanism, which would have allowed them to be opened by hand. Despite several attempts and assistance from the environmental engineer, the second engineer could not release the door lock. The chief engineer saw the second and environmental engineers trying to open the doors and tried to release the lock himself, without success. The environmental engineer explained that, in order to save time, he would be satisfied if they carried on with the rest of the inspection and sent him a photograph of the lift pit later on.

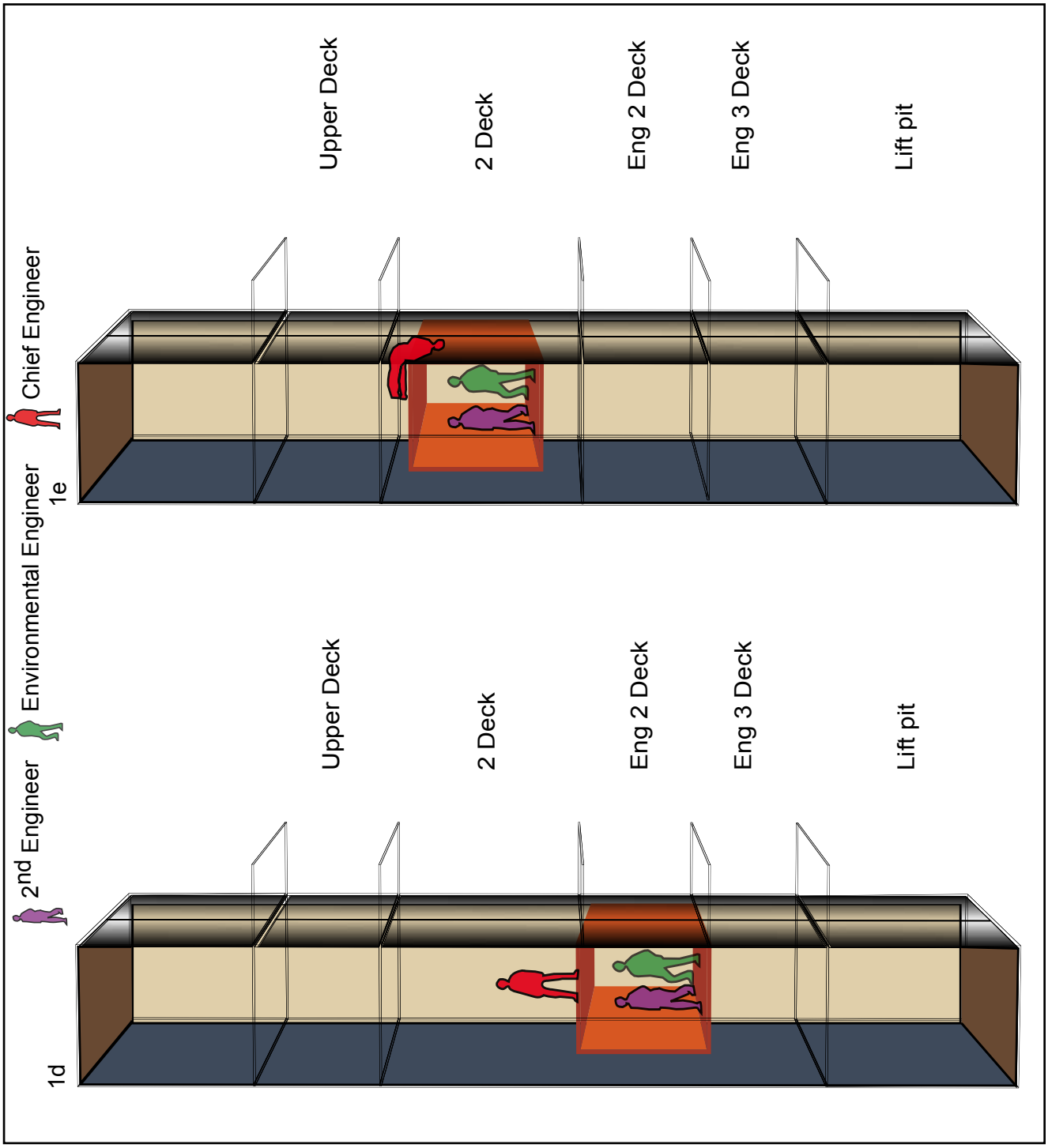
1.3.3 The accident

At around 1055 the chief engineer, apparently frustrated by not being able to open the doors, took the stairs up to the engine room 2nd deck. Once there **(Figure 1c)**, he entered the lift car and, without explanation, began to climb up through the emergency escape hatch. The second and environmental engineers had followed him, and the environmental engineer shouted a warning to the chief engineer not to climb into the lift shaft. The chief engineer carried on through the open emergency escape hatch and on to the lift car roof. He then closed the hatch behind him **(Figure 1d)**.



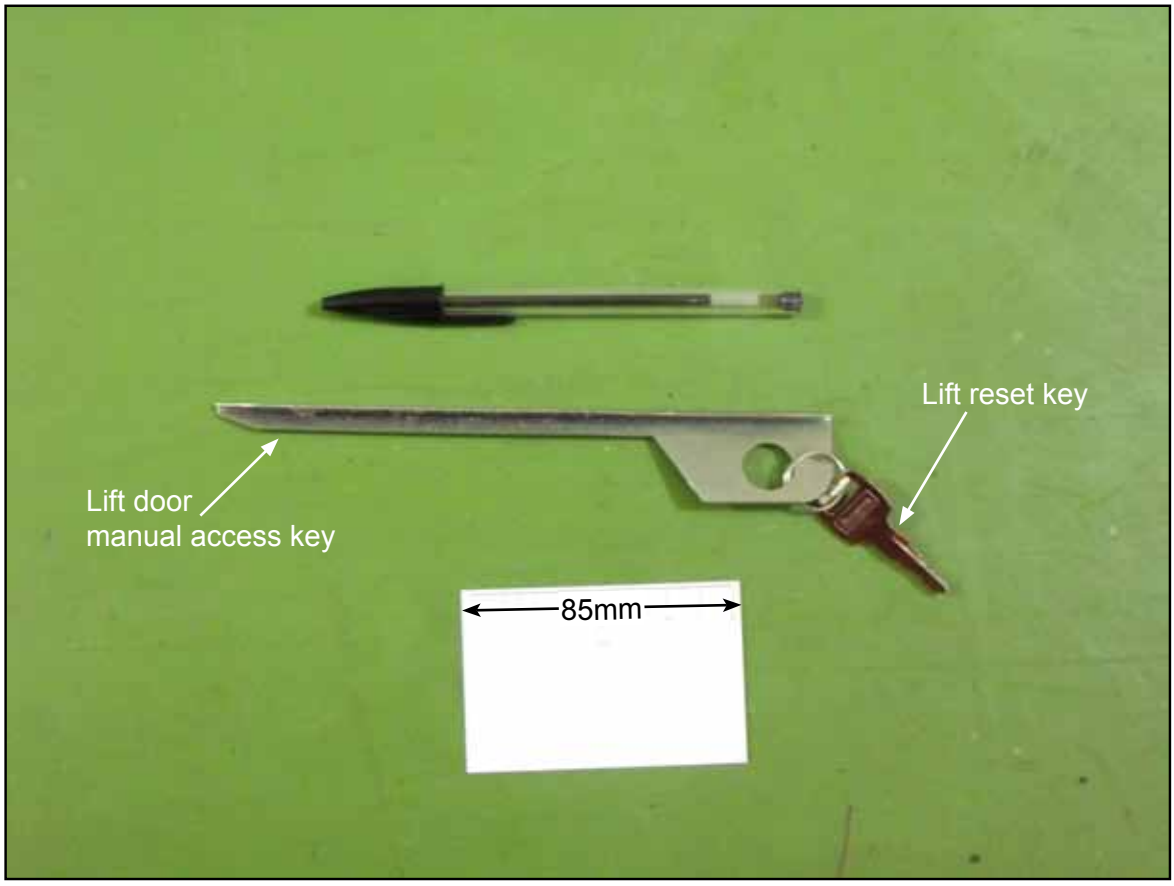
Schematic diagram of accident narrative

Figure 1



Schematic diagram of accident narrative

Figure 2a



Lift shaft door manual access key and reset key

Figure 2b

Lift reset switch - located in lift car

Although the chief engineer had not explained what he intended to do, the second engineer assumed that, as the hatch door had been closed, the chief engineer had switched the lift to '*manual*' mode, using the controls on top of the lift car **(Figure 3)** so that he could move the lift car up or down as required.

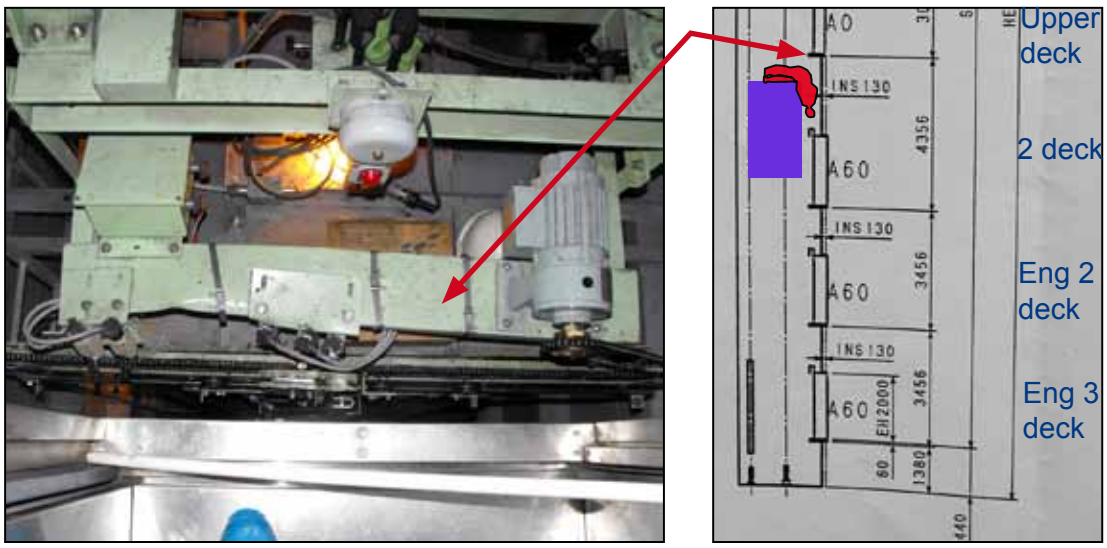
Figure 3

Lift car emergency escape hatch and local control switches

The second engineer also saw that the lift car control panel was unlit, and interpreted this to mean that the chief engineer had taken manual control. In order to allow the lift to respond to manual commands, the second engineer turned and released the emergency stop button, and then turned the reset key that was attached to the lift door access key **(Figures 2a and 2b)**.

At about 1100 the lift car doors closed, and the environmental and second engineers felt the lift ascend. The second engineer sensed that something was wrong, and pushed the emergency stop button inside the lift car. The second and environmental engineers then climbed out of the escape hatch on to the lift car roof. They saw the chief engineer on the other side of the lift shaft, trapped between the lift car and the underside of the sill at the upper deck **(Figure 4)**. They called to the chief engineer, but heard no response and saw no movement.

Figure 4



Casualty location

1.3.4 Emergency response

The second engineer pushed the upper deck lift shaft doors apart from inside the lift shaft, and shouted for help. The chief officer was in the cargo office nearby, and came to assist. At about 1105 the chief officer telephoned the deputy junior vice president (port captain) to advise him of the situation. The chief officer then called the emergency services. The port captain telephoned the port engineer on board *Ever Excel* and instructed him to assist. The port captain then contacted a local company of lift technicians to ask them to help release the chief engineer.

1.3.5 Evacuation

The port engineer went to the lift and found that the controls on top of the lift car had not been switched to the manual mode. The lift was therefore in automatic mode. The port engineer switched to manual mode and attempted to move the lift downwards, but the machinery did not respond.

The second engineer went to the lift machinery room on the navigation bridge deck in order to try and release the chief engineer by lowering the lift by hand. He attempted to release the electric brake, and then removed machinery guards

to allow him to fit the turning handle. Unaware that the electric brake had not been released correctly, the second engineer snapped the drive shaft by turning the handle with too much force. It was no longer possible to lower the lift car by hand.

At 1130 an ambulance crew arrived on board and attempted to release the chief engineer, with the assistance of the ship's crewmen, by forcing the lift car downwards. This was unsuccessful. Shortly afterwards, the lift technicians arrived at the scene, and one of them was able to bypass the lift's safety interlocks and lowered the lift in *'manual'* mode using the controls on the lift car top. The chief engineer was then lifted clear and, at 1220, was carried by stretcher to 'A' deck, and placed ashore using the ship's stores crane. He was transferred to a waiting ambulance and taken to hospital, accompanied by his wife, but unfortunately he could not be revived.

1.4 EVERGREEN MARINE (UK)'S INITIAL RESPONSE TO THE ACCIDENT

The day after the accident, EMU issued a marine circular, '*Safety measures on elevator maintenance'* **(Annex A)**, establishing a detailed work procedure for lift inspection and maintenance. It also required that a risk assessment was carried out and that instruction manuals be studied before any further work took place on lifts. However, the circular did not accurately reflect the full safety precautions stated in the lift manufacturer's instruction manual. A further marine circular, clarifying the procedure, was issued to the fleet 8 weeks later.

1.5 VESSEL GENERAL PERMIT

EMU's fleet was advised of the implementation of the VGP requirements by a marine circular sent in February 2009. The VGP required a system of inspections, corrective actions, record keeping, and reports to be established for the management of 26 different types of discharges from ships when trading in the USA **(Annex B)**.

The environmental engineer had sent a schedule for the preliminary VGP inspection to *Ever Excel*, showing the scope of the inspection with planned timings **(Annex C)**. There were no plans for controlling any of the risks associated with the inspection, such as gaining access to machinery.

1.5.1 External compliance pressures

In 2005, EMU's parent company, Evergreen Marine Group was fined $25 million by the US Government when the company pleaded guilty to concealing the deliberate, illegal discharge of waste oil. The charges included making false statements, obstruction of Coast Guard inspections and failing to maintain an accurate Oil Record Book[2]. None of the vessels investigated for the violations were managed by EMU.

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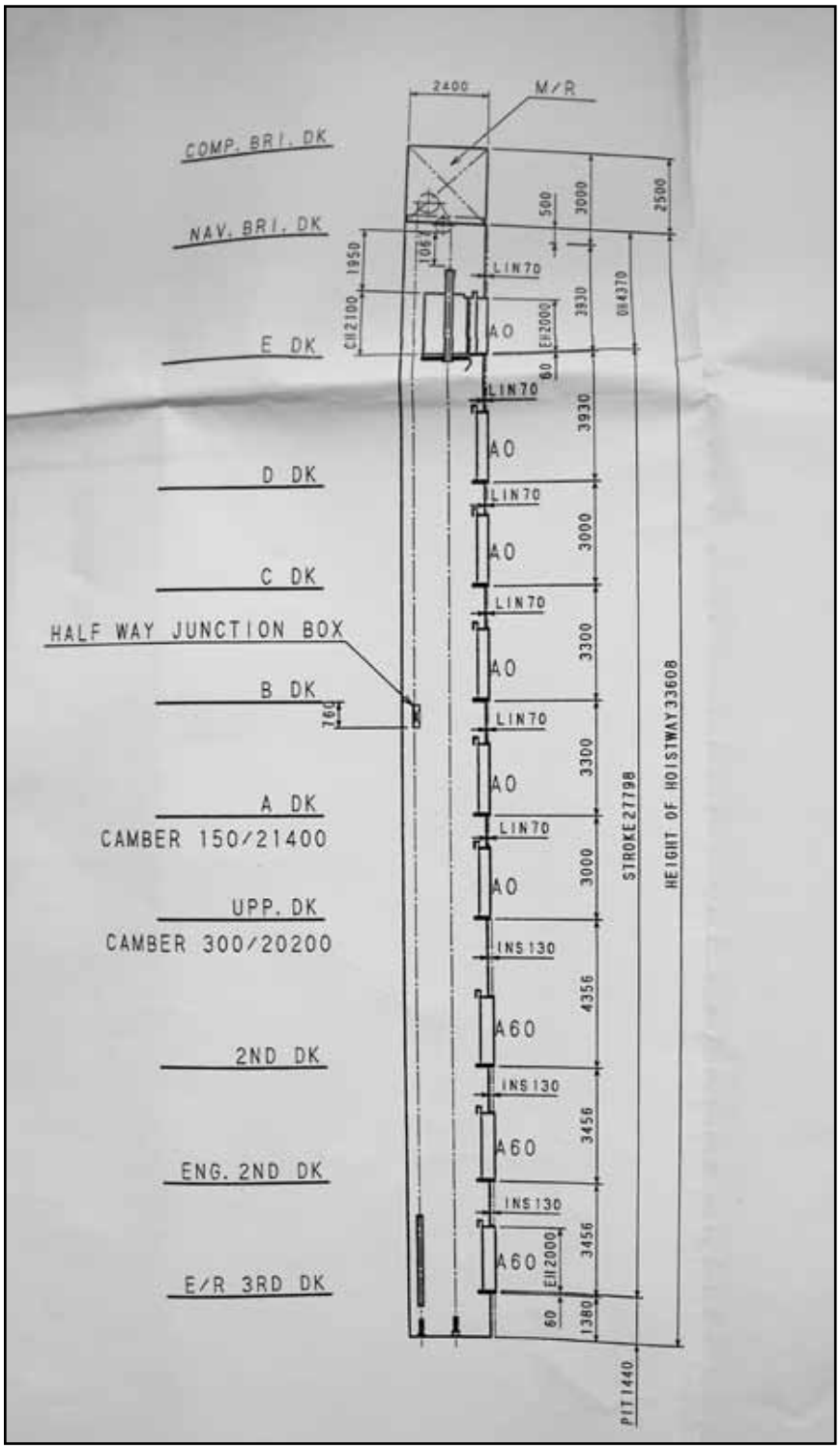
2 US Coast Guard Press Release dated 4 April 2005 (http://www.d13publicaffairs.com/go/doc/21/67946/Evergreen-shipping-company-to-pay-25-million)

1.6 THE LIFT

The lift was manufactured by Schindler, and had a capacity of 7 persons or 550kg. It was powered by an 11kW motor producing a lift speed of 55m per minute. The lift served 9 decks and the shaft was 28m in height **(Figure 5)**.

Figure 5



Lift shaft plan

1.6.1 Operating manuals

The lift operation and maintenance manuals were written in English and were held on board in the engine control room. The manuals described procedures for entering the pit and working on top of the lift car **(Annex D)**.

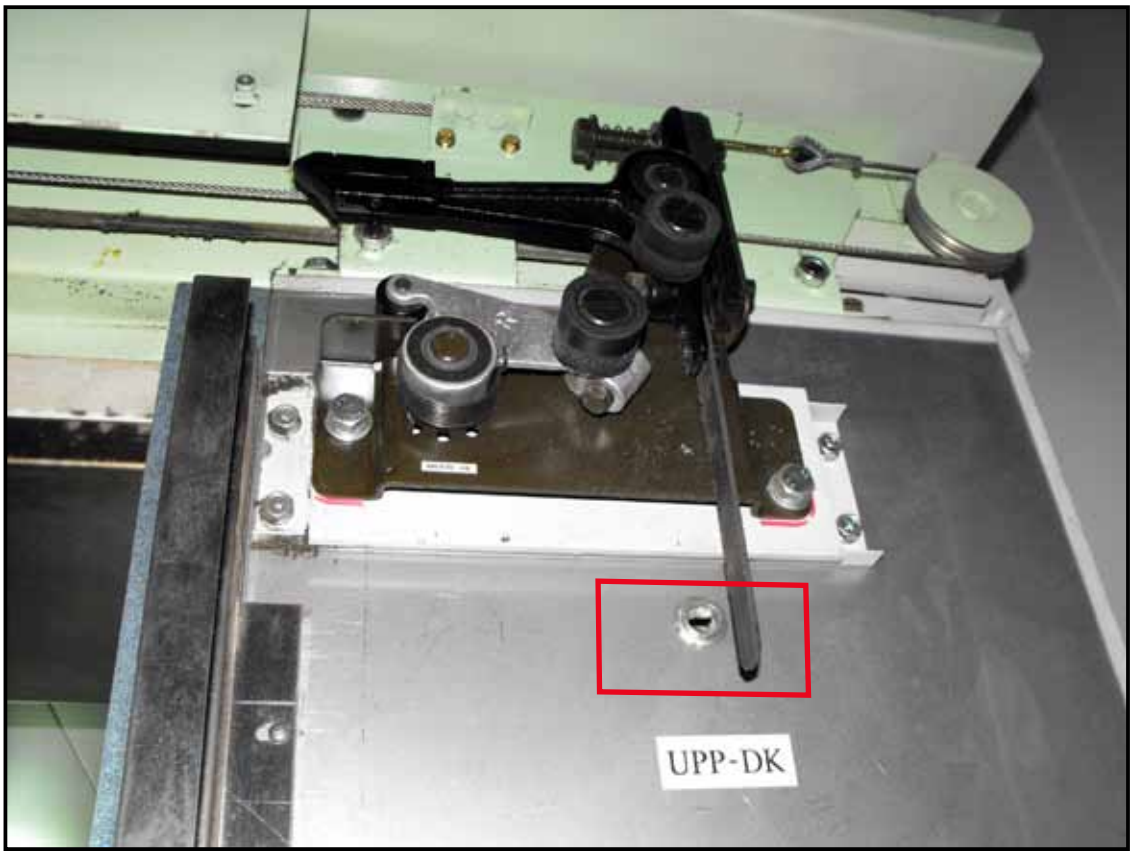
1.6.2 Opening of lift shaft doors

Weekly checks of effluent in the lift pit, and the rescue of personnel trapped in the lift, required crew to be able to open the lift shaft doors manually. A metal probe, referred to as a 'key' **(Figure 2a)**, was kept in the engine control room, and this fitted into an access hole in the top left corner of each of the lift shaft doors. Moving the key from side to side **(Figure 6a)** allowed it to engage with a lever **(Figure 6b)** which, in turn, released the door locking mechanism. The mechanical drive was also disconnected, allowing the doors to be pushed open against the resistance of a counter-weight.

Figure 6a

Lift shaft door manual opening

Figure 6b



Lift shaft door locking mechanism

1.6.3 Lift-pit inspection for VGP

EMU issued guidelines to its fleet describing the operating procedures to be followed for each of the discharges **(Annex E)** in the scope of the VGP. The procedure for checking effluent in the lift pit was to '*Periodically (weekly) inspect and maintain in good housekeeping*', then record the inspection in the '*Check list form'* and the '*Engine Log Book'* [sic].

The most recent VGP inspection was recorded in the checklist as having been carried out 2 days prior to the accident. Neither the checklist nor the engine room logbook contained a record of whether or not the lift pit had been included in the inspection.

1.6.4 The fourth engineer's VGP inspections

The fourth engineer was responsible for carrying out the weekly checks of the lift pit. During the investigation, MAIB inspectors asked the fourth engineer to open the engine room 3rd deck lift shaft doors. Initially, he took the wrong 'key' from the engine control room key box. After being shown the correct 'key', he put it in the access hole and turned it both clockwise and anti-clockwise, bending it in

the process. He was unable to open the lift shaft doors. However, the lift doors were subsequently manually opened by the MAIB inspectors once the 'key' had been moved in the correct sideways direction within the access hole to engage the lever which released the door mechanism.

1.6.5 Working on top of the lift car

The manufacturer's manual stated that two people were needed for work activities on top of the lift car **(Annex D)**. The procedure required one person to be stationed in the lift machinery room (at the top of the lift shaft) while the other operated the controls on the top of the lift car. Two-way radios were a prerequisite for communications between the two people. The description in the manual included the following:

- The person in the lift machinery room should turn off the main power supply breaker to access the control cabinet, and switch over the '*BS switch*' to prevent the lift responding to automatic calls.
- The person in the lift car should open the emergency hatch (activating a safety interlock), climb onto the lift car top and change the operating switch from '*Auto*' to '*Man*'[ual], to allow use of the lift car top controls.
- Power should be restored to the lift machinery and the system '*reset*' using either of the key operated switches in the lift machinery room or the lift car itself. Controls on top of the lift car can then be used to operate the lift up and down at slow speed.
- Additionally the '*Safety switch*' on the lift car top could be turned from '*Normal*' to '*Stop*' to prevent the lift car from responding to any commands. [sic]

Additional safety interlocks, that stopped the lift from moving if it was called, were activated when any of the lift shaft doors, or the access hatch between the lift machinery room and the lift shaft, were opened. An emergency stop switch was also fitted inside the lift car.

1.6.6 Emergency escape

The procedure to rescue a passenger from the lift in an emergency **(Annex F)** was contained in the operating manual. This also included how to operate the brake release device **(Figure 7)** to allow the lift to be raised or lowered manually by fitting a handle to the lift motor. The procedure was also posted on the bulkhead inside the lift machinery room. An access ladder was provided throughout the whole length of the lift shaft. It was possible to get a limited view of the lift pit from the top of the lift car by looking down the lift shaft in the area of the access ladder.

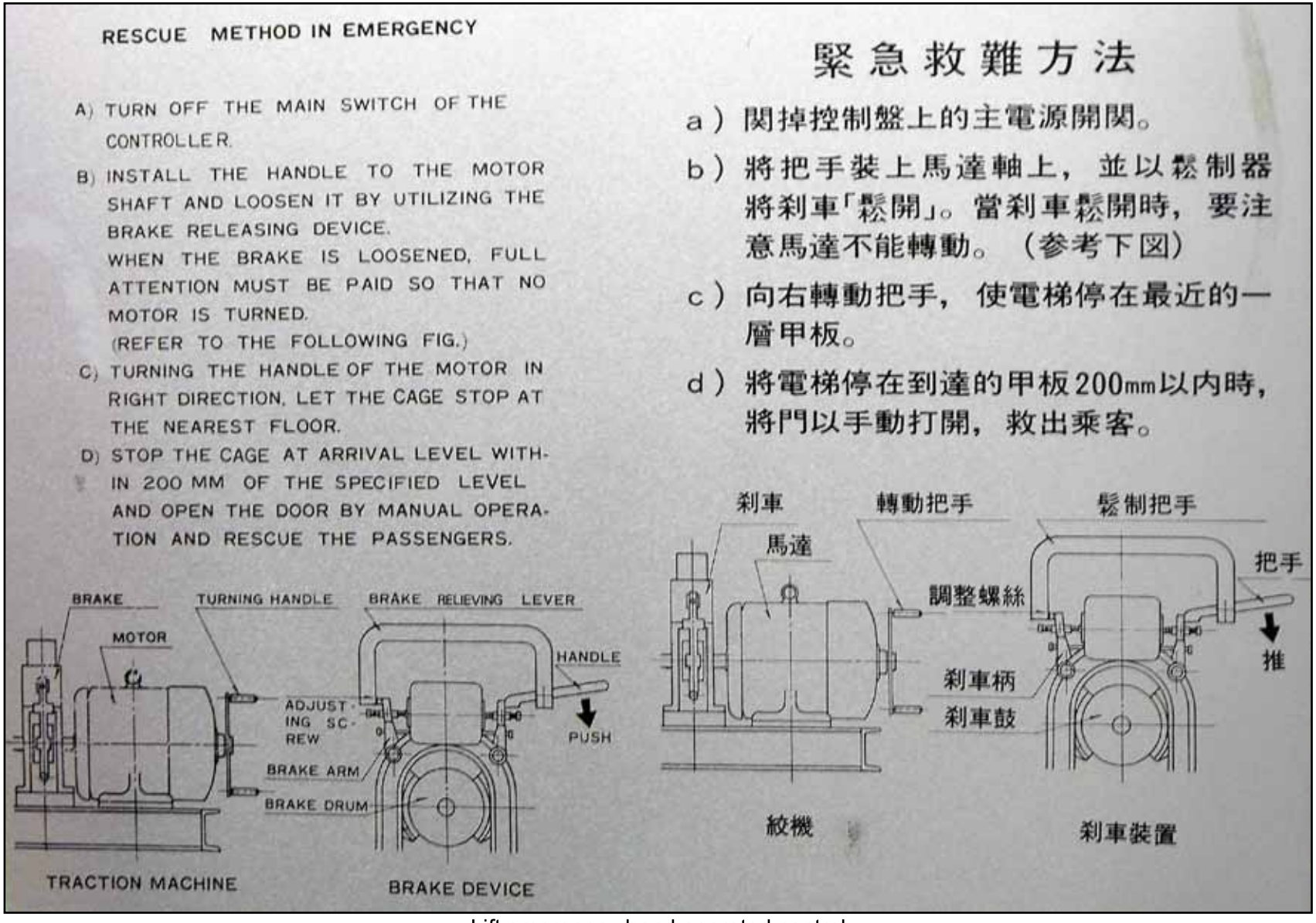


Figure 7

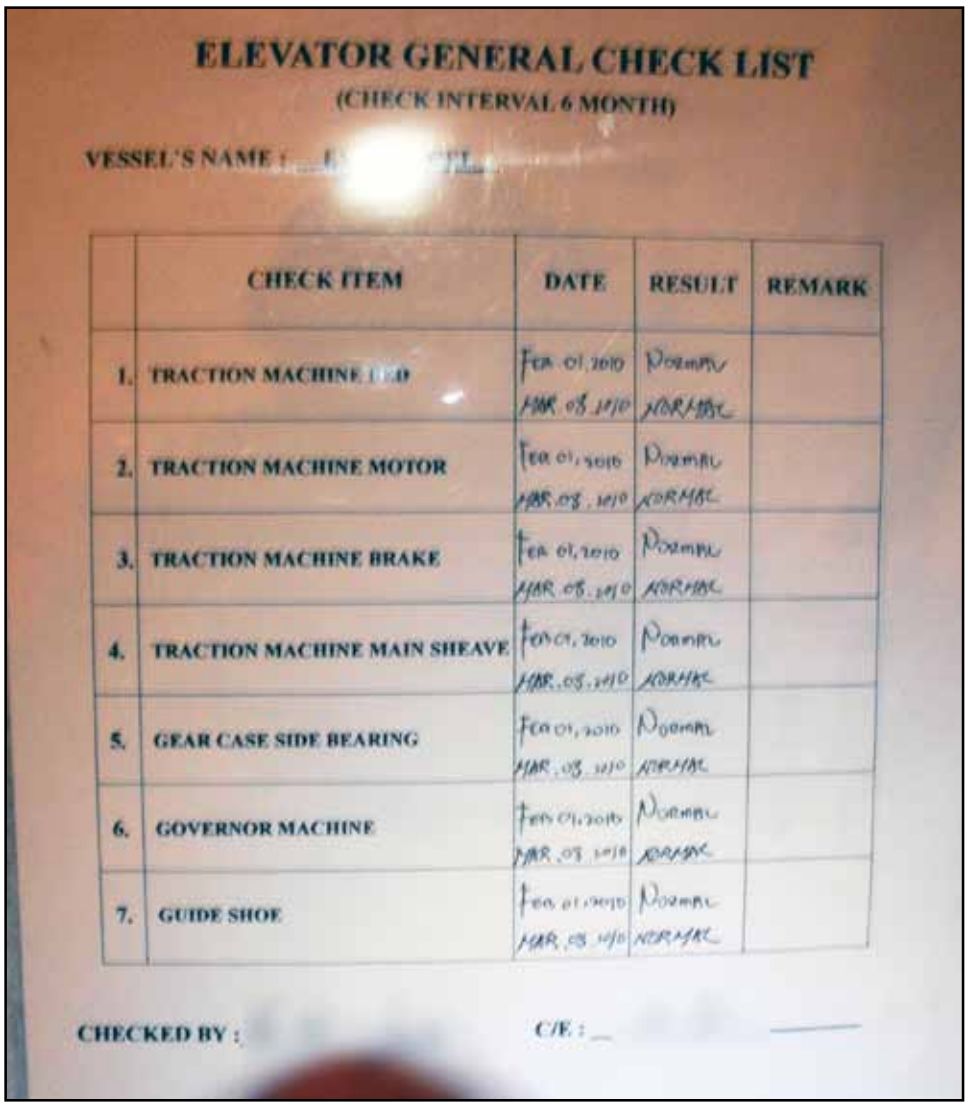
Lift emergency hand operated control

1.6.7 Lift maintenance

Annual maintenance on the lift was carried out by a shore contractor while *Ever Excel* was in Kaohsiung. EMU's vessel maintenance planning system (VMPS) also stated that the second engineer was to conduct '*Elevator - General check and greasing'* every 6 months.

The list of items to be checked was posted in the lift car **(Figure 8)**. This showed when the checks had been carried out and whether they were satisfactory. According to the VMPS database and the notices posted in the lift at the time of the accident, all the routine maintenance schedules for the lift had been completed.

Figure 8



ELEVATOR GENERAL CHECK LIST

(CHECK INTERVAL 6 MONTH)

VESSEL'S NAME :

	CHECK ITEM	DATE	RESULT	REMARK
1.	TRACTION MACHINE [illegible]	FEB 01, 2010 MAR 03, 2010	NORMAL NORMAL	
2.	TRACTION MACHINE MOTOR	FEB 01, 2010 MAR 03, 2010	NORMAL NORMAL	
3.	TRACTION MACHINE BRAKE	FEB 01, 2010 MAR 03, 2010	NORMAL NORMAL	
4.	TRACTION MACHINE MAIN SHEAVE	FEB 01, 2010 MAR 03, 2010	NORMAL NORMAL	
5.	GEAR CASE SIDE BEARING	FEB 01, 2010 MAR 03, 2010	NORMAL NORMAL	
6.	GOVERNOR MACHINE	FEB 01, 2010 MAR 03, 2010	NORMAL NORMAL	
7.	GUIDE SHOE	FEB 01, 2010 MAR 03, 2010	NORMAL NORMAL	

CHECKED BY :

C/E :

Elevator general checklist

Prior to the accident, the lift was in good condition and functioned correctly. The lift pit was clean, with very small quantities of oil residues collected in save-alls **(Figure 9)**.

Figure 9

Lift pit

1.7 CREW

1.7.1 Manning

Ever Excel had a crew of 17, which was in excess of the safe manning certificate. All the senior officers were Taiwanese, the remaining officers and crew were Filipino nationals. All crew could expect to work on any of the ships in Evergreen Marine Group's fleet and were not restricted to vessels managed by EMU.

Evergreen Marine Group required the Taiwanese officers and crew to work contracts that were about 11 months long; Filipino officers and crew worked 9-month contracts. The four engineering officers worked during the day, and each covered the unmanned machinery space (UMS) overnight duty in turn. All deck and engineering officers were required to be on duty whenever the ship arrived or left port.

1.7.2 Ship's personnel

The master was a 62 year old Taiwanese national. He held an STCW[3] unlimited II/2 certificate of competency and had been a master with the Evergreen Marine Group's fleet for 20 years, including 10 years ashore as port captain. He had been on board for 8 months.

[3] The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

The chief engineer, Mr Lii Ming, was a 56 year old Taiwanese national and was reaching the end of his 11-month contract. He held an unlimited STCW III/2 certificate of competency, and had 26 years' experience at sea; 22 years as chief engineer with the Evergreen Marine Group, including 5 years ashore as a port engineer. Mr Lii Ming had undergone an annual medical in January 2010 and was passed as medically fit; he was 173cm tall, weighed 87kg and was overweight. The death certificate stated that he had died as a result of '*Asphyxiation*' due to '*chest pressed by machine at work*'.

The second engineer was a 55 year old Taiwanese national. He held an unlimited STCW III/2 certificate of competency and had 20 years' experience at sea, the last 10 years with Evergreen Marine Group. He had been on board for 6 months and was the departmental safety representative.

The chief officer was a 39 year old Taiwanese national. He held an unlimited STCW II/2 certificate of competency and had been with the Evergreen Marine Group fleet for 12 years. He had been on board for 12 months, and was the ship's safety officer.

The fourth engineer was a 34 year old Filipino national. He held an STCW III/1 certificate of competency and had been at sea for 4 years, the last 2 years with Evergreen Marine Group. He had been on board for 6 months.

1.7.3 Shore personnel on board at the time of the accident

The port chief engineer, referred to in this report as the port engineer, was based in Evergreen Marine Group's Taipei office. He was on board to oversee the main engine maintenance and was responsible for the technical oversight of the ship. He was a qualified marine engineer and held an STCW III/2 certificate of competency.

The port engineer, referred to in this report as the environmental engineer, was based in EMU's Taipei office. He held a degree in engineering and was responsible for the fleet's compliance with environmental legislation and maintaining the company's International Organization for Standardization (ISO) 14001 certification.

1.7.4 Crew knowledge and training

Ever Excel's crew did not include an electrician and therefore electrical work was carried out by the ship's engineers, supported by specialist shore-based staff when required.

No familiarisation, training or guidance was provided to the ship's engineers for working on the lift. Working methods were developed informally and passed verbally from officer to officer; a system that had evolved throughout the Evergreen Marine Group fleet.

1.8 REGULATIONS AND GUIDANCE

The Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997 and the Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) (LOLER) are the most relevant regulations to this accident. Practical guidance for implementing these statutory obligations is provided by the Maritime and Coastguard Agency (MCA) in Marine Guidance Notes (MGN) and in the Code of Safe Working Practices for Merchant Seamen (COSWP). Copies of COSWP were provided on board *Ever Excel* and were available as required by UK regulations.

1.8.1 Lifting equipment

MGN 332[4], regarding the implementation of lifting equipment regulations, states that:

- Only those trained and competent to do so should operate any lifting appliance.
- Instruction should be given to the vessel's personnel to enable them to appreciate factors affecting the safe operation of lifting appliances.
- Training and safety information for those on board should include an understanding of the relevant sections of COSWP.

1.8.2 Guidance in the Code of Safe Working Practices for Merchant Seamen

COSWP provided guidance on how to conduct an initial and detailed risk assessment. It also provided detailed information on the specific risks associated with working on lifts, in Section 20.12 - Personnel Lifts and Lift Machinery **(Annex G)**. The most relevant points are summarised below:

- Regular examination must be carried out by a competent person at intervals not exceeding 6 months and a certificate or report issued.
- An initial risk assessment must be made to identify hazards associated with work on each lift installation, including work requiring access to the lift trunk.
- Safe working procedures must be drawn up for each lift installation. Persons who are to be authorised to carry out work on, or inspection of the lift installation must comply with these procedures.
- It is recommended that a permit-to-work system is adopted when it is necessary for personnel to enter the lift trunk or to override the control safety systems.
- Any work carried out on lifts must only be performed by authorised persons familiar with the work and the appropriate safe working procedures.
- Appropriate safety signs must be prominently displayed in the area and also on control equipment such as lift call buttons. Barriers must be used when it is necessary for lift shaft doors to remain open to the lift trunk.
- Before attempting to gain access to the trunk, whenever possible the mains switch should be locked in the OFF position.

[4] The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006

COSWP also emphasises the importance of effective communication when working with lifts:

'Experience indicates that the most important single factor in minimising risk of accidents is the avoidance of misunderstandings between personnel. A means of communication to the authorising officer and between those involved in working on the lift must be established and maintained at all times. This might be by telephone, portable-hand held radio or a person-to person chain. Whatever the arrangement, action should only be taken as a result of the positive receipt of confirmation that the message is understood.'

1.9 OWNERSHIP AND OPERATION

EMU was based in London and was one of several companies that formed the Evergreen Marine Group, whose combined fleet totalled more than 170 ships. *Ever Excel* was one of 11 container ships managed by EMU. EMU was responsible for the safety management of its ships and had its own management system. Technical management and manning were primarily controlled by sister companies in the Evergreen Marine Group, based in Taiwan.

Although UK-registered since her launch in 2002, because the majority of the crew were Taiwanese and Evergreen Marine Group's headquarters were in Taiwan, in practical terms *Ever Excel*'s home port was Kaohsiung.

1.9.1 Company training

Evergreen Marine Group's training centre in Taiwan provided various deck and engine training courses, including bridge resource management training using the company's own bridge simulator, and technical courses using an engine room simulator. A variety of STCW and bespoke short courses were provided for the company's officers and ratings.

1.10 SAFETY MANAGEMENT PROCEDURES ON BOARD

1.10.1 Health and Safety Policy

The company's Health and Safety Policy **(Annex H)** dated January 2010 stated that:

'The principal aim of our policy is to encourage the development and the maintenance of a sound safety and effective occupational health culture of the highest level amongst all employees within Evergreen Marine (UK) Ltd'.

1.10.2 The safety management system

In addition to complying with the International Maritime Organization's (IMO) International Safety Management (ISM) code, EMU's health, safety, quality and environmental management system (HSQEMS) had also been assessed as meeting the following:

- ISO 9001: 2008 quality standard
- ISO 14001: 2004 environmental standard

EMU operated its fleet to ISO 18001-1999 occupational health and safety management systems standard, although this was not externally assessed.

The HSQEMS was unique to EMU, and other companies in Evergreen Marine Group used their own systems. The system was available to all crew on board and consisted of four sections: policy manual, procedures manual, working manual and forms.

1.10.3 Marine circulars

Marine circulars were the main method of disseminating safety information to the fleet. In 2009, 30 marine circulars were issued. These were temporary notifications that were intended to be transferred to the HSQEMS, or cancelled in due course. However this had not been done routinely and the majority remained valid, existing in parallel with the main part of the HSQEMS.

In 2005 a marine circular was sent to the fleet, entitled '*To provide a briefing of working/safety instruction to the involved crew prior to carrying out a particular task or operation*' **(Annex I)**. This circular aimed to develop, establish and maintain a 'Safety Culture' and to minimise accidents on board. The circular followed a review of accidents that had occurred in the Evergreen Marine Group fleet, which had found that several accidents had been caused by '*human negligence*' through '*wrong and careless operation*'.

The circular identified previous examples of accidents that may reoccur on board. It included '*Maintenance of the elevator or crane without collaborative work or giving safety instructions prior to doing the task may cause possible risk*'. The circular required that consideration be given to providing clear work instructions, working in accordance with COSWP and referring to the manufacturer's instructions.

This circular remained valid at the time of the accident and had not been transferred into the HSQEMS.

1.10.4 Risk assessment

Risk assessment was required to be carried out by the work procedure '*Risk assessment for shipboard operations*', issued in May 2007. An explanatory flow chart described the '*process of risk assessment and control*', and a form entitled '*Risk Assessment for Shipboard Working Activities'* was provided.

A marine circular '*The introduction of risk assessment*' dated 25 September 2009 stated that the standard of risk assessments had been unsatisfactory. Further instructions were given on the completion of the *'initial risk assessment*' and '*detailed risk assessment forms'* primarily following the method described in COSWP. However these instructions were different, and contradictory, to the procedure published in May 2007, which also remained extant. The 2009

circular also appointed the chief officer and second engineer as responsible for assisting other officers and completing risk assessments. An example of a completed risk assessment was included, but no training was provided.

An annex to the circular contained a list of 59 deck department activities and 71 engine department activities, 130 in all, for which the crew were required to complete risk assessments. The instruction encouraged additional activities to be assessed and added to the original list.

Lift maintenance and inspection was not included in the list of activities that required risk assessments.

At the time of the accident on board *Ever Excel,* 11 risk assessments were found dated 31 December 2007. Between mid May and mid August 2008 a further 7 risk assessments were added, making a total of 18 that had been completed. No further progress had been made on the 130 risk assessments that were identified in September 2009.

1.10.5 Permit to work system

The HSQEMS working manual instruction '*Special shipboard operations*', provided procedures for safety critical operations; specifically:

- Hot work
- Enclosed space entry
- Working outboard or aloft
- Helicopter operations
- Checking of cargo lashings
- Stability
- Securing for sea
- Other occasional special operations.

The requirement for '*other occasional special operations'* stated:

> *'Whilst carrying out the other occasional special operations on board, the master and operational person in charge should refer to the "Code of Safe Working Practices for Merchant Seamen (MCA) Chapter 1 to assess the risk of operation prior to conducting the work, and if necessary, the master or operational person in charge should develop their own safety checklist or working permit to take all necessary precaution against safety risks..'* [sic]

Permit to work templates were provided for the activities listed above, where there was a risk of injury to personnel, and several had been completed in the months prior to the accident. No permits to work for '*other occasional special operations'* were found in the ship's records.

1.10.6 Ship's safety committee

The master chaired the ship's safety committee meetings with the chief officer (safety officer), second officer, second engineer and one of the deck ratings appointed as safety representatives. Safety committee meetings were held monthly, and all crew members were required to attend.

The standard agenda for the meeting comprised reviews of: previous accidents and near-misses; previous company instructions; onboard training, and company safety procedures **(Annex J)**. Minutes of the meetings were sent to EMU managers, but there was no evidence of any feedback from the crew about safety management procedures, or their effectiveness, in minutes from the 4 months preceding the accident.

1.10.7 Near-miss reporting

In 2007, an HSQEMS work procedure was issued to the fleet establishing a near-miss reporting system with the objective of learning from incidents without apportioning blame in accordance with guidance from the IMO.

In January 2010, a marine circular was sent to the fleet that re-emphasised near-miss reporting as a key part of the ship's safety culture. The circular required the master to report near-misses at least quarterly, and encouraged everyone on board to report and discuss near-misses without fear of being blamed **(Annex K)**.

No near-misses were recorded on *Ever Excel* in the 6 months before this accident, and there were no other records to indicate that the effectiveness of working practices had been discussed among the crew.

1.10.8 Master's review of the HSQEMS

Each master was required to submit a review of shipboard operational issues, evaluate the effectiveness of the HSQEMS and make proposals for improvements. A review was required at least once during a master's contract, or annually if the contract exceeded 1 year.

1.10.9 Emergency procedures

The HSQEMS working manual contained guidance for the ship's emergency response to accidents and emergencies. The procedures detailed the actions to be taken and frequency of drills required to enable the crew to respond to emergencies such as grounding, fire, pollution and man overboard. The section on '*crew serious injury, illness or death'* provided no explicit instructions, but referred the reader to the ship captain's medical guide and the instruction for '*personal injury, crew serious injury, illness and death*' contained in the booklet 'Gard[5] guidance to masters'.

[5] Gard Protection and Indemnity (P&I) Club (Bermuda) Ltd.

1.11 THE MAINTENANCE SYSTEM

Planned maintenance schedules for the lift were included in EMU's computerised Vessel Maintenance Planning System (VMPS), which generated job sheets listing the tasks to be carried out each month.

The VMPS database was developed in-house for use on all ships in the Evergreen Marine Group. Requests to amend or add items to the VMPS had to be made by ship's staff or company managers to a central computer support section. The database was focused on the main engine and major machinery, and it contained around 700 line items. EMU's managers acknowledged that the content was limited by the difficulties in making changes to the system.

The system did not describe any detail of what was required for each maintenance task. It did not include links to risk assessments, work procedures or note whether a permit to work was required for the task.

Unplanned maintenance and defect repairs that were carried out by the ship's engineers could not be recorded in the VMPS and instead were written in the engine room logbook.

1.12 EMU'S VERIFICATION OF THE SMS

1.12.1 Internal audit of *Ever Excel*

Ever Excel's last internal audit was carried out in August 2009. No non-conformities were raised. Only minor observations regarding galley cleanliness and fitting of bulldog clips on the lifeboat fall wires were noted.

The audit report stated that the master and senior officers were fully committed to implementing the HSQEMS, but it did not comment on the process of compiling risk assessments on board.

1.12.2 Fleet management reviews

EMU's 2009-10 annual fleet management review **(Annex L)** recorded a total of six accidents (including the two earlier fatal accidents). Five of these were categorized as "operational human error". Nine near-misses were reported.

The management review found that '*one of the root causes of these accidents is the lack of personal safety awareness which was frequently ignored by shipboard personnel, even when they had received training since they had joined the ship*' [sic]. The conclusion was drawn that safety relied on personnel carrying out work using the procedures that had been provided, and applying the safety measures that already existed.

The review went on to identify that a '*safety culture must be developed among the crew by upgrading personal protective equipment to be more convenient for [the] user, improving safe working procedures, auditing and reviewing crew's performance to gain safety awareness of shipboard personnel*' [sic]. It was also found that some safety officers did not have a full understanding of mandatory (UK) safety regulations and guidance in COSWP.

Eleven masters' reviews were received for the year. Eight observations were made, of which only three referred to shipboard operations. Three reviews contained no comments at all. The management review stated that '*reviewing the report of Master's review, we are* [satisfied with] *the results of shipboard management*' [sic].

EMU's 2008-9 fleet management review found that all non-conformities and observations across the fleet had been corrected by ships' crew without the need for managers to intervene. Three external non-conformities were identified:

- The lift was not maintained in accordance with COSWP as no service report was available
- Risk assessments and hot work permits had not been issued
- Lack of near-miss reports on board.

Two accidents, including one personal injury, and a total of eight near-misses were reported. Only one near-miss report had been received in the previous year (2007-8).

Thirteen reviews completed by several masters were received in 2008-9; most of the comments related to minor changes to the wording of HSQEMS documentation. No comments were made regarding operational hazards or the effectiveness of safety management procedures.

1.13 EXTERNAL VERIFICATION

1.13.1 External audits: *Ever Excel*

In September 2008 the MCA carried out audits of the following systems on board *Ever Excel*:

- ISM Code Safety Management Certificate (SMC)
- ISO 9001:2000 quality system
- ISO 14001:2004 environmental system
- International Ship and Port Facility Security Code.

The audit to renew the SMC did not identify any non-conformities, but five observations were made. These included that while significant stevedore damage had been recorded on board, no near-miss reports had been raised, and that the lift's 6-monthly inspection report was not available as required.

In July 2010, following this accident, the MCA carried out an additional ISM SMC audit. This recorded four non-conformities, including '*Inadequate risk assessments and safeguards for identified risks*'. The audit report acknowledged that more detailed risk assessments, safe work procedures and standard operating procedures (SOP) were being developed, but noted that further training would be required to ensure that crews followed the new procedures diligently.

1.13.2 Additional audits: EMU

On 20 January 2010, following the two fatal accidents aboard EMU operated vessels in 2009, the MCA carried out an additional, detailed ISM audit at EMU's London office. The scope of the audit was to review work procedures, including:

- Risk assessments
- Emergency response procedures on board and ashore
- Actions being taken to investigate the causes of accidents
- Measures being taken to prevent recurrence, and improve overall safety on board EMU's vessels.

The audit found that more needed to be done to improve the safety culture on board. Of greatest concern, it found little evidence of genuine communication with ship's staff, of crew making suggestions, or responding to the instructions given. Risk assessments required further development, and safe work procedures still needed to be written. The auditor provided written guidance on how EMU could improve its risk assessment methodology.

With regard to maintenance, the audit report stated that the company's VMPS did not contain instructions as to the scope of the maintenance required, and did not include links to the appropriate risk assessment, noting that '*such detail is not required by regulations but is regularly seen in other company* [s] *maintenance systems'.*

1.13.3 Follow-up actions

EMU requested that MCA provide assistance and suggestions to improve the company's safety culture, and in February 2010 the MCA responded with detailed advice. This included:

- Setting challenging targets for the completion of risk assessments and safe work procedures.
- Encouraging and setting targets for near-miss reporting.
- Appointing a company health and safety manager to:
  - Oversee the writing of risk assessments and Standard Operating Procedures (SOPs).
  - Adopt a "step analysis" method of writing risk assessment and SOPs.

  - Review and improve safety training ashore and on board.
  - Sail with the ships to train the crews.
  - Become fully familiar with current health and safety legislation and guidance.
  - Train crew in the use of COSWP.
- Asking for guidance from the Evergreen Corporation's airline division, or EMU's P&I club.
- Using external expertise to audit and train.
- Providing easy to use manuals with photographs, or DVDs showing SOPs.

On 19 April 2010, 2 days prior to this accident, the MCA carried out an annual ISM Document of Compliance (DOC) audit of EMU.

The audit report stated that:

'Despite the company apparently taking safety aspects very seriously the recent overall safety performance of the vessels has been poor with two deaths of crewmembers having occurred. This may indicate the need for greater and more urgent commitment to enhancing the safety culture on board the vessels'.

In May 2010, following this, the third fatal accident, the MCA's director of marine services wrote to EMU's chairman expressing his concerns about the company's implementation of the ISM Code, and stating that continued ISM certification by the MCA was being re-considered.

On 3 June 2010 EMU's chairman replied to the MCA's director of marine services with a letter **(Annex M)** stating the actions that had been taken to enhance its safety culture. These were:

- '*Detailed review of risk assessment before 1 July 2010*
- *Further development and review of safe working procedures according to risk assessment*
- *Marine circulars of increasing safety awareness have been sent to all the fleet*
- *Inspection/visiting (superintendent) to our ships will be increased by 50%*
- *Safety target 2010-2011 with zero tolerance policy related to death has been set*
- *Additional study of other international regulations for our reference*
- *Close partnership with our Training Centre in Taiwan to develop courses related to safety with aim to improve awareness of safe working activities on board.*

Please note that we will be dealing with any infringement severely, under the zero tolerance policy, we will penalize the person(s) who breaches the rules and the safety officer. The punishment includes dismissal and a record of demerit.' [sic]

In June 2010 these measures were issued to the fleet in a marine circular **(Annex N)**.

On 7 July 2010 the MCA carried out an additional ISM DOC audit of the EMU office in Taiwan, a branch office of EMU's London office.

The audit raised two non-conformities:

- '*The maintenance system is not in compliance with UK Lifting Operations and Lifting Appliances Regulations*'.
- '*Safety officer training set out in COSWP has not been provided*'.

The audit also found that there was no evidence of crew using the '*Corrective and preventative action report'* to report self-identified non-conformities. In the auditor's view, based on the number of fatal accidents, not enough near- misses were being reported.

1.14 SAFETY CULTURE

The IMO resolution A.1022(26), '*Guidelines on implementation of the International Safety Management (ISM) Code by Administrations'*, states that the application of the ISM Code should

'*support and encourage the development of a safety culture in shipping'*.

The preamble to the 2010 edition of the ISM Code states:

'The cornerstone of good safety management is commitment from the top. In matters of safety and pollution prevention it is the commitment, competence, attitudes and motivation of individuals at all levels that demonstrates the end result'

1.14.1 Near-miss reporting and *'just culture'*

The 2010 edition of the ISM Code includes guidance on near-miss reporting **(Annex O)** reproducing a circular[6] published in October 2008. The circular states that companies should investigate near-misses as a regulatory requirement under the '*Hazardous Occurrences'* part of the ISM Code. Learning lessons from near-misses should help to improve safety performance because the underlying issues can be the same as those found in serious accidents. Recording, analysing and acting on the lessons learned from near-misses should be used to drive continuous improvement in safety management systems.

[6] MSC-MEPC.7/Circ7 dated 10 October 2008

The circular describes barriers to the reporting of near-misses, such as the fear of being blamed, disciplined, embarrassed, or being found legally liable. The benefits can be achieved only when those involved are assured that reporting near-misses will not result in punitive measures. The circular states that companies must have a clear policy on how people will be treated if they report a near-miss, and that managers must be sincere about addressing safety issues.

The IMO recommends adopting a '*just culture'* that features an atmosphere of responsible behaviour and trust whereby people are encouraged to provide essential safety-related information without fear of negative consequences.

1.14.2 Communication

EMU acknowledged that achieving effective communication between the office managers and the ship's masters, and from the masters to the officers and crew, was problematic. It was recognised that the effects of national and corporate culture made it more likely that instructions from superiors would be accepted without being challenged. Junior members of the organisation were seen as being unlikely to give any feedback to their seniors that might be perceived as being critical or negative.

This view of the limitations of effective communication was supported by academic study. Hofstede[7] identified the ways in which the national cultures of over 50 different countries influenced communications. The studies found that Taiwan was one of the most '*highly collectivist*' nations[8] and that the national culture of hierarchy and group success could restrict communication.

1.15 OTHER FATAL ACCIDENTS IN THE EMU FLEET

The other fatal accidents that occurred on *Ever Elite* and *Ever Smile* were examined to identify common safety issues.

1.15.1 *Ever Elite*

On 10 September 2009, an able seaman from *Ever Elite*[9] drowned after the lower section of the accommodation ladder he was standing on broke free and fell into the water.

The accommodation ladder fell when the hoist winch gearbox failed; the gearbox had been incorrectly re-assembled by the ship's crew following maintenance. Rigging the ladder when underway was unnecessarily hazardous and a safe

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[7] Geert Hofstede - Cultures and Organizations 1991

[8] Ranked 44th out of the 53 countries and regions considered

[9] MAIB – Report on the investigation of the uncontrolled descent of an accommodation ladder from the container ship *Ever Elite*, San Francisco Bay 10 September 2009 resulting in one fatality. Report No 8/2010. Published July 2010. (http://www.maib.gov.uk/publications/investigation_reports/2010/ever_elite.cfm

system of work had not been developed. The seaman was not wearing a fall-arrest device or a lifejacket, both of which should have been required for working over the side.

Four days after the accident EMU issued a Marine Circular '*Safety of accommodation ladder operation*' to the fleet. The circular prohibited the rigging of accommodation ladders until the ship was secured alongside, required a risk assessment to be done, permit to work issued, and the correct use of personal protective equipment. The maintenance requirements for accommodation ladders were reiterated.

In October 2009 EMU issued a Marine Circular on '*Working Safety'* **(Annex P)**, which requested personnel to ensure that they were familiar with manufacturers' instruction manuals for the equipment they worked on. The circular also stated that crew should have a thorough knowledge of the HSQEMS, COSWP and marine circulars.

Following the investigation, the MAIB made recommendations to EMU to strengthen its safety culture and improve the maintenance management systems on board its vessels.

1.15.2 *Ever Smile*

On 19 November 2009, in rough seas and heavy swell, *Ever Smile* was approaching port, carrying sufficient speed to counter a strong cross-current. The aft tug approached and its messenger line was sent on board. The line was being heaved in when it 'jumped' off the tug's winch drum. This was due to excessive tension in the line as the tug was unable to keep up enough speed to maintain station with the ship. A crewman on the aft mooring deck of *Ever Smile* tried to hold onto the messenger line, but his feet became entangled and he was pulled overboard through a fairlead. The ship continued into port while the aft tug started to search for the missing crewman; his body was found several days later.

The MAIB monitored EMU's investigation into the accident and received a copy of its report. EMU's investigation found that:

- The crewman lacked safety awareness, despite company training and familiarisation.
- The pilot station was located too close to the breakwater to allow enough time for the tugs to be made fast before the vessel's speed needed to be increased to counter the tidal stream while passing through the breakwater.
- The tug took too much tension on the messenger line in an attempt to keep the tug's line clear of the water in a heavy seaway.
- Consideration should be given to making the tugs fast inside the harbour breakwater.

The day after the accident, EMU sent a marine circular to the fleet issuing instructions on '*safety of making fast and casting off tug lines'*.

EMU's report did not consider the effectiveness of any existing safe working procedures or risk assessments for mooring. It did not refer to any near-miss reports, question why the crewman had apparently ignored company safety awareness training, or identify any underlying safety issues.

1.15.3 Other accidents

During this investigation, a number of other accidents on board EMU's vessels were identified that had not been reported to the MAIB. These included a vessel running aground, and two occupational accidents that resulted in injuries to crewmen.

1.16 PREVIOUS FATAL ACCIDENTS INVOLVING PASSENGER LIFTS

1.16.1 *British Mallard*

On 27 January 2007, engineers and an electrical technician on the tanker *British Mallard* attempted to rectify a problem with the lift doors. The second engineer asked if the lift machinery had been isolated. He was told by his colleagues that the lift machinery had been secured and that 'do not operate' signs had been placed at all the landings.

After making some adjustments to the door switches, the electrical technician stepped onto the ladder in the lift shaft and asked the second engineer to let the doors close behind him. Soon after the doors closed, the lift car started to travel upwards and, after a few seconds, it stopped. The electrical technician was trapped between the lift car and the ladder, and was killed.

The accident was investigated by the Australian Transport Safety Bureau (ATSB), whose report[10] identified that:

- The elevator instruction manuals did not provide the crew with sufficiently detailed and unambiguous safety guidance.
- The ship's permit to work and risk assessment processes were not used.
- The electrical technician and engineers were either not aware of, or did not consider, all of the hazards associated with working in the elevator shaft.

1.16.2 *MSC Colombia*

The MAIB conducted a preliminary examination following the fatal accident on board the container ship *MSC Colombia* on 8 August 2007, where an electrical cadet was crushed and killed while working on the lift.

[10] Australian Transport Safety Bureau – Independent investigation into the crewmember fatality on board the Isle of Man registered oil tanker *British Mallard* while berthed in Kwinana, Western Australia 27 January 2007

The underlying safety issues were found to be:

- The electrical cadet did not fully understand how the lift operated
- Crew had not followed the advice in COSWP for safe working procedures on lifts
- The company's procedures for conducting risk assessments and issuing permits to work had not been followed.

SECTION 2 - ANALYSIS

2.1 AIM

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

2.2 THE ACCIDENT

2.2.1 Preparation and inspection

None of the engineers had any formal training in lift maintenance, and they had not consulted the manufacturer's instructions or guidance in COSWP before commencing the VGP inspection. Therefore, it is not surprising that they did not take the correct precautions or that they were unable to open the lift shaft doors. However, by opening the lift shaft doors and operating the lift's emergency stop, two safety interlocks would have been activated, and these would have prevented the lift car from moving while the pit inspection took place.

2.2.2 Deviation from the original task

Once the chief engineer became aware that his staff could not open the lift shaft doors on the engine room 3rd deck, his actions demonstrated that he was very focused on completing the checks on the lift pit. Despite warnings from the environmental engineer, he apparently made no attempts to adopt a safe system of work.

The chief engineer put himself in a very vulnerable position by climbing on top of the lift car and shutting the emergency hatch. With the hatch open the lift would not move, but by closing the hatch the chief engineer restored one of the safety interlocks. The second engineer assumed that the chief engineer would take manual control of the lift and, in order to assist him, released the last remaining interlock and reset the system. This put the lift back to its normal operating condition.

It is not known if the lift was called from another deck, or whether it responded to a request stored in the system's memory. However, it is likely that it moved at the normal operating speed, rather than the slow speed of the manual mode. The acceleration of the lift car would have given the chief engineer very little time to move to safety. Consequently, he became trapped between the lift car and the sill of the lift shaft door above, such that it asphyxiated him.

2.2.3 Chief engineer's intentions

It cannot be stated with certainty what the chief engineer intended to do on the lift car top. However, the combination of the following factors makes it unlikely that he intended to take manual control of the lift:

- It would have been easiest for him to switch the lift to manual control as he was climbing through the escape hatch; however, the controls were found to be still in the automatic mode immediately after the accident.

- The chief engineer was found on the opposite side of the lift car from the controls. In order to get to that position he would have had to climb over the substantial cable attachment structure. This would have been awkward for a man of his build, and therefore was a deliberate act, which also moved him away from the manual controls.
- It would have been difficult for the chief engineer to lean back across the cable attachment structure to reach or operate the controls.

Given the determination shown by the chief engineer to carry on with the lift pit inspection and to obtain the required photographs, it is more likely that he assumed that the lift car was adequately secured. Therefore it is probable that he was going to look over the side of the lift car either to check the feasibility of taking a photograph, or to check how the lift shaft door locking mechanism worked. As the access ladder restricted the chief engineer's view of the lift pit, it is less likely that he was attempting to photograph the pit. It is considered most likely that he was looking to see how the lift shaft door mechanism worked so that he could then return to the engine room 3rd deck and open the lift shaft doors to inspect and photograph the lift pit.

2.2.4 Emergency response

The lift stopped moving after the chief engineer became trapped, probably because the motor was overloaded and the electrical protection devices tripped. The second engineer opened the lift shaft doors when he called for help, so the system would have needed to be reset before the lift could be moved in the manual mode. This was not done, and therefore the port engineer's attempts to release the chief engineer were unsuccessful.

It was not possible to move the lift by using a hand crank until an electro-magnetically operated brake had been released. This was not done correctly, and so the drive shaft broke when it was forced by the second engineer. The lift car was held firmly in position by the brake, and attempts to physically force the lift car down were ineffective and only caused further damage.

While it is likely that little could have been done to save the chief engineer, a prompt rescue could have been a critical factor in different circumstances; for example, had the ship been at sea, or in many other ports where shore assistance was not available. Instructions on how to operate the machinery by hand were posted in the lift machinery room. However, the crew were not familiar with this operation as it had not been tested or practised. In the event, crew were not only unable to move the lift, but they also damaged it, and in doing so delayed further attempts to release the chief engineer. The requirement for familiarisation and training to deal with lift emergencies had not been identified either by the company or by the officers on board.

If work is permitted in any hazardous environment on a ship, such as a lift shaft, procedures should be established and practised to ensure that a trapped or injured worker can be rescued.

2.3 LIFT MAINTENANCE AND INSPECTION

2.3.1 VGP inspection

The fourth engineer was required to check the lift pit each week as part of EMU's VGP preparations. This was recorded as having been done a few days before the accident. However, as the fourth engineer did not know which key was required, and then demonstrated that he did not understand how to manipulate the key to open the lift shaft doors during the investigation, it is unlikely that these checks had in fact been carried out recently.

During the investigation, the lift pit was found to be clean and there were no signs of waste fluids ever having gathered there in significant amounts. It is probable that the lift pit was checked when the VGP inspection was introduced in February 2009, but that weekly checks were thereafter found to be unnecessarily frequent, and so became neglected. Crews must inform managers when procedures are impractical so that a better solution or, in this case, a more realistic periodicity can be established.

The VGP checks introduced new technical requirements, which had not been fully considered. The vessel's engineers had only a cursory knowledge of lift maintenance procedures and were ill-prepared to carry out the inspection. No-one had verified that the fourth engineer was capable of carrying out lift pit inspections, and no checks were made to see that they were being done. Consequently, *Ever Excel*'s senior engineer had not identified his staff's inability to complete the lift pit inspection. For their part, EMU managers had not been involved in planning or assessing the technical aspects of the VGP inspection and no work procedures had been provided. Specialist training had not been considered necessary, as the managers expected qualified marine engineers to be competent to work on all the machinery found on a ship, no matter how specialised the equipment, or infrequent the task.

2.3.2 Routine maintenance

Prior to this accident, no near-miss incidents involving work on *Ever Excel*'s lift had been reported to EMU. Maintenance work on the lift was approached as a routine activity, with no additional consideration of the special risks involved with lift machinery.

The second engineer was responsible for carrying out the 6-monthly maintenance tasks, all of which could be achieved by accessing the lift shaft via the emergency hatch in the lift car. By using this route and taking manual local control of the lift car, the second engineer was ensuring that he had control of the lift and it could not be inadvertently switched back to automatic mode. When conducting the 6-monthly maintenance tasks, the second engineer would not necessarily have needed to unlock the lift shaft doors manually, and maintenance could have been achieved without a need to understand how to unlock the lift shaft doors. However, when tasked to carry out the VGP

inspection of the lift pit, which involved opening the lift shaft doors, he did not seek advice or information on how to do so, nor did he tell the chief engineer that he did not know how to complete the task.

2.3.3 Vessel Maintenance Planning System

EMU's VMPS stated only what maintenance was required to be done. It did not give any guidance as to how the task should be carried out, or identify the hazards involved.

Difficulties in modifying and updating the VMPS software had two important consequences. Firstly there were relatively few maintenance items listed for a vessel of *Ever Excel*'s size and complexity. Consequently, the vessel's crew had found other ways of planning and recording maintenance, which ran in parallel with the primary system. This made it much harder to manage maintenance effectively. The second consequence was that it was impossible to link relevant guidance, hazard information, risk assessments or permits to work to a particular maintenance task. This meant that the crew had to check another, separate system for safety information, making safety appear peripheral to their main task and therefore much less likely to be considered.

EMU should consider improving its VMPS to provide a system that can be easily updated and expanded by the crew and managers as required.

2.4 UNDERLYING UNSAFE CONDITIONS

2.4.1 Work procedures

Although EMU had not provided specific work procedures on the maintenance of its vessels' lifts, detailed instructions were available in the manufacturer's manual held on board *Ever Excel*, and more general guidance was available in COSWP. Both were written in English, the crew's second language, and this undoubtedly limited their ability to absorb the information. In this case neither the chief nor second engineer thought it necessary to check the available information. The precise reason for this is not known, but earlier audits had noted that crews' knowledge of COSWP and UK regulations was generally poor. However, in this instance, the engineers' reluctance to check the information available indicated a poor understanding of the potential risks they faced, over-confidence in their own ability, and an unwillingness to seek advice.

EMU's procedure for *'occasional special operations*' had not been applied to lift maintenance or to any other activity beyond those where a permit to work was specifically required. This suggests that the permit to work procedure was applied only when it was mandatory. It therefore follows that the crew had either not identified any hazardous special operations, or had not recognised that using a permit to work could be a benefit to their safety.

As there was no safe working practice for the lift pit inspection, there were no barriers to prompt the engineers to re-consider the risks when the task changed to include working on top of the lift car. The need to complete the task overrode all but the most basic safety considerations. Other options, such as deferring, planning or even discussing the hazardous task did not come naturally to the two engineers, despite the caution voiced by the environmental engineer.

A detailed work procedure for lift inspection and maintenance was sent to the fleet immediately after this accident, just as procedures were sent following the other two fatal accidents in EMU's fleet. However, the HSQEMS can never be effective while crew either are not willing or are unable to identify hazardous activities and challenge dangerous work practices. Crew must be encouraged and trained to identify hazards, discuss safer ways of working with safety committees and managers, and take proper action to reduce the risk of accidents.

2.4.2 Similarities with other fatal lift accidents

This, and the two other fatal accidents involving lifts considered in this report, shared a number of similarities. Most significant, is that those personnel involved did not understand the equipment sufficiently well to enable them to work on it safely. In each case, guidance was available but was ignored. It is, therefore, not only essential that personnel working on lifts are properly trained and familiar with the equipment, but also that the prevailing onboard safety culture ensures appropriate safety barriers are in place to prevent a single error resulting in a serious accident.

2.5 PRESSURES ON THE CREW

Ever Excel's officers were required to be on duty whenever the ship entered or departed port. Both the chief and second engineers had been up in the early hours of the morning on both 20 and 21 April. It is therefore likely that they would have been more tired than normal.

Evergreen Marine Group had previously been found guilty of breaching environmental regulations in the US. The chief engineer would have been aware of this, and would have been anxious to ensure that the preliminary VGP inspection was successful. It would also be quite understandable for him to have been keen to finish his work as quickly as possible so that he could spend some time with his wife considering that he was on an 11-month contract. These two factors, combined with possible fatigue and his responsibility for the other concurrent work, would have put great pressure on the chief engineer, which might have increased the likelihood of him making a mistake or overlooking safety procedures.

Consideration should be given to introducing measures to balance the pressures on the crew caused by the necessarily high workload in Kaohsiung, and their natural desire to use the opportunity of a home port visit to see friends and relatives.

2.6 EFFECTIVENESS OF THE SAFETY MANAGEMENT SYSTEM

It is evident from the fatal occupational accidents on board *Ever Excel, Ever Smile* and *Ever Elite* that the common factors were poor working practices and inadequate control of risks. These factors were allowed to persist because the safety management system was ineffective. The conclusions in the company's accident reports and management reviews - that crew lacked safety awareness or had ignored safety procedures - were incomplete and masked systemic problems in the safety management system. Similarly, evidence was found of other accidents that had not been reported or investigated properly. In these instances, the aims of the company's health and safety policy were not being achieved. This was not recognised and little action had been taken to improve performance.

2.6.1 The HSQEMS

While the HSQEMS had been found to comply with the requirements of the ISM code, it was of little practical use. It provided very few work procedures and minimal guidance on how to work safely.

The HSQEMS was also unique to EMU vessels. Other Evergreen Marine Group vessels used different management systems and, as crew could expect to work on any of the group's vessels, they had the constant challenge of learning the specific requirements of each one.

2.6.2 Identification of hazards

Although the 6-monthly lift maintenance and weekly checks were company mandated tasks, there was no guidance or documentation in use at the time of the accident that identified and mitigated the risks, as required by COSWP and LOLER.

The hazards of working on lifts had previously been identified by EMU in a circular that was sent to the fleet in 2005. However this circular had not been incorporated into the HSQEMS and it had not been acted upon by the crew, who were unaware of its existence.

Safety committee meetings, internal audits, superintendents' visits and masters' reviews had all failed to discover that risks were not being identified or assessed. In this accident, the methods used to work on the lift went unchallenged, and safer ways of working were not considered.

2.6.3 Risk assessment

EMU managers had recognised that the process of risk assessment had not been implemented as required in the HSQEMS, and in September 2009 had sent out a fleet circular that described a new approach to the subject and identified 130 activities to be assessed. Lift inspection and maintenance were not specifically included, but the circular allowed additional items to be added.

Progress on working through these risk assessments had been extremely slow and, at the time of the accident, only 18 had been completed on *Ever Excel*, all of which pre-dated the 2009 circular.

The new risk assessment marine circular superseded the original HSQEMS process but, again, the HSQEMS was not updated and the two conflicting systems were both available on board.

EMU's attempts to implement risk assessment across the fleet were unsuccessful. Despite their obligation to do so, crew did not carry out the required risk assessments, did not report any problems that prevented them making progress, or ask for help. Masters did not tell EMU managers that risk assessments were not being achieved, or raise any concerns about the suitability of the system or the ability of the crew to use it.

None of the company's internal processes detected that progress with completing risk assessments was so slow. Managers were therefore unaware that their instructions were not being carried out. If the difficulties in developing effective risk assessment on board had been recognised, and the reasons for this understood, managers could have provided the additional resources that were needed.

2.6.4 Effectiveness of safety committee meetings

There was no evidence in the minutes of *Ever Excel*'s safety committee meetings of crew providing feedback to EMU managers on safety management procedures prior to the accident. Information only flowed one way, from managers to crew, and the opportunity to discuss work activities and safety procedures in order to find better ways of working was lost. Managers and senior officers got little value from the safety committee meetings; the chance to understand the hazardous work practices that took place on board their ships was missed. Similarly, crew had little influence on how best to control the risks and so became isolated from the safety management system.

2.6.5 Circular letters

EMU issued around 30 circular letters annually, and few had been incorporated into the HSQEMS. This had the effect of creating two parallel systems of work instructions, with the following consequences:

- Conflicting instructions were issued. Examples included the conflicting instructions for completing risk assessments; and the '*no blame*' policy for near-miss reporting which conflicted with the '*zero tolerance leading to disciplinary action*' policy for safety procedure infringements.
- New work procedures, such as those issued after the previous fatal accidents and hazards of working on lifts, were lost among many other circulars because they were not transferred into the HSQEMS.

Although the need to send information to the fleet promptly is important, managers had fallen into a habit of discharging their responsibilities by issuing circulars, but not then checking to ascertain that the problems which prompted the circulars had been solved.

2.6.6 Management reviews

EMU's reviews of the HSQEMS showed that very few near-misses were recorded in comparison to the number of serious accidents experienced. This was contrary to widespread evidence that for every accident there will normally have been several near-misses. The lack of feedback from masters' reviews and safety committee meetings was noted, but was not interpreted as being any cause for concern.

Crew, and particularly senior officers, need to understand the purpose of reviews and their role in improving safety. Without good quality information on how the safety management system was working, and how hazards were being controlled in practice, managers could neither understand, nor attempt to improve working practices on board ships in their fleet. Masters' reviews and minutes from safety committee meetings were not critically examined and minimal information was accepted by managers.

Effective communication between ships' staff and shore management is vital to ensuring that managers have a true picture of how their ships operate, and the risks that their crews face.

2.7 EXTERNAL VERIFICATION OF THE SMS

The MCA, in its scheduled and additional ISM audits, has attempted to assist EMU with the identification and assessment of risks, greater reporting of near-misses and other initiatives to help the company in developing its safety culture. The system was found to meet the basic requirements of the ISM Code, but had remained at an early state of development and lacked the continuous improvement that was needed to make it an effective safety management tool.

Company documents dating back to 2005 stated that a safety culture needed to be developed, but EMU's responses largely addressed low-level points of detail and lacked clear direction in how to make any significant improvement. This illustrates an apparent lack of commitment from the company's top management to understand the underlying issues and make the necessary changes prior to this accident.

2.8 SAFETY CULTURE

The communication required to enable an effective company safety culture to evolve was not evident either on board *Ever Excel,* or between the crew and the managers ashore.

The second engineer preferred to make an assumption about the chief engineer's intentions rather than to ask him for clarification, stop the hazardous task, or at least not reset the lift's safety interlocks until the situation became clear.

Masters' reviews, near-miss reporting, internal audits and safety committees all existed. However, none had identified that management systems, such as risk assessment, were not being developed effectively. Managers ashore were therefore not aware of the true state of the HSQEMS.

EMU has acknowledged that communications within the company have been hindered by corporate and national culture; a problem that has also been identified by academic research. EMU must intensify its efforts to improve communication and find ways to counter these natural barriers.

The company's two objectives of increasing near-miss reporting, and to discipline crew members and safety officers who breach safety rules, were confusing and contradictory. The policies were inconsistent and did not reflect the *'just safety culture'* described in the ISM code. The message to personnel was unclear as to whether reporting a near-miss would have a positive or negative outcome.

That EMU's system did not provide sufficient barriers to prevent accidents, was evident, as was the organisation's inability to ensure that existing safety management procedures were established on board. The company's safety management culture did not continually improve, but remained immature as the system did not develop beyond the implementation phase.

While EMU had continued to pass instruction and responsibility to crew, there was little evidence of managers accepting a similar responsibility to make sure that their instructions were working on board their vessels. Review of EMU's safety management system is required, from the most fundamental level, to improve the current confused and incomplete system.

Substantial commitment, over the long term, is required from EMU and sister companies within the Evergreen Marine Group to develop the existing system from one that meets only the most basic level of compliance, to one that is properly effective in supporting crew and managers and that can deliver the aims of EMU's declared safety policy.

SECTION 3 - CONCLUSIONS

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

1. None of the engineers had any formal training in lift maintenance and the lift car had not been electrically isolated in accordance with the manufacturer's manual or guidance in COSWP. [2.2.1]

2. There were no apparent attempts to reassess the situation or consider safer ways of working after the lift doors could not be opened. It was evident that completing the task was considered more important than working safely. [2.2.1]

3. Lack of planning and communication led to safety interlocks being reset while the lift controls were in the automatic mode. This allowed the lift car to move, trapping the chief engineer against the door sill of the deck above. [2.2.2]

4. It is unlikely that the chief engineer intended to take manual control of the lift. It was more likely he was attempting to look at the lift shaft door locking mechanism without first putting in place adequate safeguards. [2.2.3]

5. The crew were unable to release the chief engineer, and damaged the lift machinery in their attempts, because emergency operation of the lift had not been practised. If work is permitted in any hazardous environment on a ship, such as a lift shaft, procedures should be established and practised to ensure that a trapped worker can be rescued. [2.2.4]

6. The VGP inspections introduced new technical requirements which had not been properly considered. All the engineers had gained their knowledge of lift maintenance informally, and managers had not been involved in planning or assessing the technical aspects of the inspection. [2.3.1]

7. When tasked to carry out the VGP inspection of the lift pit, which involved opening the lift shaft doors, the second engineer did not seek advice or information on how to do so, nor did he tell the chief engineer that he did not know how to complete the task. [2.3.2]

8. There was no work procedure for inspecting the lift. Crew did not consult guidance in the manufacturer's manual and COSWP, and did not apply the company's 'permit to work' system. Crew must be encouraged to identify hazards and take proper action to reduce the risk of accidents. [2.4.1]

9. It is likely that a combination of fatigue, the need to get a considerable amount of work done in a limited time, and the desire to see his wife placed greater pressure on the chief engineer. This would have increased the likelihood of him making a mistake or overlooking safety procedures. [2.5]

10. The hazards of working on lifts had previously been identified in a circular issued in 2005, but this had not been incorporated into the HSQEMS and was not referred to on *Ever Excel*. There was nothing in use at the time of the accident that identified and mitigated the risks of lift working, as required by LOLER and COSWP. [2.6.2]

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

1. The VMPS was difficult to update and could not be linked to safety information. Consequently, safety related information was peripheral to the maintenance tasks, making it less likely to be consulted. [2.3.3]

2. The similarities found between this and other fatal accidents in lifts were that those involved did not understand the equipment sufficiently well to enable them to work on it safely, and that guidance was available, but ignored. [2.4.2]

3. Evidence from this and the two previous fatal accidents demonstrates that poor working practices and inadequate control of risks were systemic problems on EMU's vessels. The aims of EMU's health and safety policy were not being achieved, but this had not been recognised and little action had been taken to improve performance. [2.6]

4. While the HSQEMS had been found to comply with the requirements of the ISM code, it contained very few work procedures and minimal guidance on how to work safely. [2.6.1]

5. Progress in completing risk assessments on Ever Excel was extremely slow. Crew did not report that they were having problems and none of the company's internal processes raised any concerns. If the difficulties in developing effective risk assessments had been understood, managers could have provided the extra resources that were needed. [2.6.3]

6. There was little feedback from crew regarding safety management procedures and the opportunity for managers to understand the hazardous work practices that took place on their ships was missed. Similarly, crew had little influence on how best to control the hazards and became isolated from the safety management system. [2.6.4]

7. Circular letters to the fleet were not routinely incorporated into the HSQEMS. This had the effect of creating a parallel, and at times conflicting, set of safety management procedures. [2.6.5]

8. Management reviews had identified the lack of feedback from crew but did not recognise it as a cause for concern. Managers lacked good quality information on how the safety management system was working in practice and could neither understand, nor attempt to improve safe working practices on board. [2.6.6]

9. Despite considerable assistance from the MCA, the HSQEMS developed little beyond meeting the most basic requirements of the ISM Code. Improvements were generally limited to low level points of detail and did not address underlying issues. [2.7]

10. Weak communication, an inability to recognise and control hazards, and confused and contradictory instructions illustrate that substantial commitment is required to develop the safety culture on EMU vessels to meet the aims and objectives of EMU's declared safety policy. [2.8]

SECTION 4 - ACTION TAKEN

4.1 EVERGREEN MARINE (UK) LIMITED

Met with the MCA to set out the improvements that have been made to date, and its future plans to improve safety.

In addition, EMU has:

- Carried out an additional study of international and UK legislation and guidance.
- Formed a Health, Safety and Environment Committee that meets quarterly.
- Increased ship inspections by 50%, with superintendents sailing with the ships and reporting to the Health, Safety and Environment committee.
- Started a detailed review of risk assessment, work procedures and the permit to work system.
- Sent a marine circular to the fleet to increase safety awareness.
- Set a safety target for 2010/11 with a zero tolerance policy related to death.
- Started to develop safety awareness and safe working practices courses at the group's training centre in Taiwan.
- Established a zero tolerance policy to breaches of safety rules, with punishment including dismissal and/or a record of demerit.
- EMU's president will visit the ships to emphasise the commitment of senior management to improving the safety culture.
- Pledged additional resources and personnel to actively support the improvement of the SMS.
- Started a programme of additional training for shore-based personnel in the ISM code and ISO requirements.
- Further promoted effective communication, including providing anonymous mailboxes, on board company ships.
- Developed Key Performance Indicators (KPI) to assess the company's continual improvement.
- Developed a company 'Action Plan for continuous improvement'.
- Committed to upgrading the VMPS to enable the system to provide a link to the associated risk assessment and safe working procedure.

4.2 THE MARITIME AND COASTGUARD AGENCY

Met with the senior management of EMU and recommended further action, including:

- Developing a plan to achieve a *'just safety culture'* on board its ships.
- Using advice in the MCA's publication '*The Human Element*'.
- Establishing how progress can be measured and performance indicators set.
- Improving risk assessment and safe working practices.
- Encouraging crew to follow company and COSWP safety procedures.
- Managing the impact of cultural issues on communication and encouraging feedback from the crew.

Further progress meetings are planned.

SECTION 5 - RECOMMENDATIONS

2011/114 In demonstrating its commitment at the highest management level to developing a robust, just safety culture throughout its fleet, **Evergreen Marine (UK) Limited** is recommended to:

- Provide sufficient resources to drive continuous improvement of its SMS over the long term.
- Assess all identified risks and establish appropriate safeguards.
- Actively involve personnel at all levels both ashore and on board.
- Promote effective communication and the reporting of near-misses, non-conformities and improvements to safety management procedures.
- Evaluate improvements to the safety culture over the long term.

Marine Accident Investigation Branch
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