Report on the investigation

of the failure of a mooring bollard from the

Class V passenger vessel

Star Clipper

resulting in a fatal accident at

St Katharine's Pier, River Thames, London

on

2 May 2004

Marine Accident Investigation Branch
Carlton House
Carlton Place
Southampton
United Kingdom
SO15 2DZ

Report No 3/2005
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Extract from

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 1999 – Regulation 4:

The fundamental purpose of investigating an accident under these Regulations is to determine its circumstances and the cause with the aim of improving the safety of life at sea and the avoidance of accidents in the future. It is not the purpose to apportion liability, nor, except so far as is necessary to achieve the fundamental purpose, to apportion blame.

NOTE

This report is not written with liability in mind and is not intended to be used in court for the purpose of litigation. It endeavours to identify and analyse the relevant safety issues pertaining to the specific accident, and to make recommendations aimed at preventing similar accidents in the future.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

BS	-	British Standard
CG	-	Coastguard
CPR	-	Cardiopulmonary resuscitation
CRE	-	Collins River Enterprises
GRP	-	Glass reinforced plastic
HEMS	-	Helicopter Emergency Medical Services
HSAW		Health and Safety at Work
HSE	-	Health and Safety Executive
LAS	-	London Ambulance Service
LED	-	light emitting diode
LP	-	Limited Partnership
LR	-	Lloyd’s Register
MCA	-	Maritime and Coastguard Agency
MSU	-	Marine Support Unit
PLA	-	Port of London Authority
rpm	-	revolutions per minute
TIG	-	Tungsten Inert Gas
UTC	-	Universal Co-ordinated Time
V	-	volts
VHF	-	Very High Frequency

GLOSSARY OF TERMS

Ahead way	-	Forward motion
Doubler plate	-	A plate that is welded or riveted on top of another plate to provide stiffening or sealing.
Fetch up	-	Securing of a vessel to a mooring arrangement.
Insert plate	-	A plate that is welded in place of a removed section.
Lay up	-	A period in which a vessel is out of service and is usually unmanned.
Pin hitch	-	A method of securing a rope to a bollard or cleat.
Running turn	-	A rope that is passed around a bollard or cleat allowing the operator some control of the vessel. The rope is not secured and rope can be let out or hauled in.
Spring	-	A method of assisting berthing or unberthing, using the power of the vessel to act against a secured rope or hawser.
Standing off	-	A vessel that is waiting to move to a position.
Tonnef	-	Measurement of the breaking strain of a rope.

SYNOPSIS

At approximately 1258, on Sunday 2 May 2004, a mooring bollard was torn from the deck of the Class V fast catamaran, *Star Clipper,* striking a female passenger waiting to board. The lady's injuries were fatal.

Owned by Collins River Enterprises (CRE) Ltd, *Star Clipper* provides a commuter shuttle ferry service on the River Thames between Masthouse Terrace Pier and Savoy Pier. On the day of the accident, she was making a routine approach onto St Katharine's Pier, having previously called at Bankside Pier. The weather conditions were good, it was high water and there was very little tidal stream. There was negligible swell, but the wash from small craft in the vicinity caused surface disturbance and movement of St Katharine's Pier.

Between 30 and 35 people were on the pier waiting for *Star Clipper* and other river services. As the vessel made the approach, her mate, standing at the port passenger entrance, passed the eye of a polypropylene berthing rope over a pier bollard and secured it loosely onto one of the vessel's bollards. The captain manoeuvred *Star Clipper* to align with the pier and vessel passenger gates. When the vessel was about 1.5m from the pier, the rope was secured and slight ahead power maintained to bring her alongside.

Just prior to coming alongside, *Star Clipper*'s mooring bollard was torn from the deck and was catapulted over the 1.1m pier safety fence. It struck one of the waiting passengers, causing fatal injuries.

The captain of *Star Clipper* immediately alerted Woolwich Radio and requested the attendance of an ambulance. The injured lady, who was with her husband, was initially given first-aid by waiting passengers and soon afterwards by the crew of the PLA harbour services launch *Westbourne.* The Tower Pier lifeboat, which had been activated, arrived on the scene at approximately 1306 and its crew took over and began CPR. Very soon, the London Ambulance Service paramedics arrived, followed by the HEMS doctor. The lady was transferred to the Royal London Hospital at 1358. She died from her injuries at 1434.

The mooring bollards fitted in *Star Clipper'*s passenger access areas were not part of the original build specification. The design of the solid stainless steel bollard and base plate that failed on 2 May had evolved empirically through a series of modifications in reaction to earlier, less catastrophic, failures. The MCA had not been informed of these failures, nor was it consulted over the subsequent proposed modifications.

On 9 April 2004, the same bollard had been torn from *Star Clipper'*s deck. The resulting repair work failed catastrophically, allowing the bollard and attached insert plate to be catapulted into the waiting passengers less than 1 month later.

In an effort to prevent a repeat of this tragic accident, the MAIB has issued several recommendations. The recommendations focus on the need for the MCA to check mooring fittings during its periodic surveys, and for the owners to seek professional advice when considering repairs or changes to fittings that are critical to the vessel's safety, to ensure these are undertaken to an appropriate standard.

Star Clipper

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *STAR CLIPPER* AND ACCIDENT

Vessel details

Registered owner	:	Collins River Enterprises Ltd
Port of registry	:	London
Flag	:	UK
Official No	:	721856
Type	:	Class V passenger vessel
Built	:	Built by FBM Marine Limited, Cowes, Isle of Wight in 1992.
Construction	:	Twin GRP composite hulls with aluminium superstructure.
Length overall	:	23.65m
Gross tonnage	:	60.7
Maximum passengers	:	62
Engine power and/or type	:	Two Scania DSI -11 diesel engines driving two Rival Calzona IRC39D water jets with controllable buckets each developing 250kW at 1800 rpm. Electric control of twin rudders with emergency manual hydraulic steering from the bridge.
Service speed	:	Variable between 10 and 23 knots due to River Thames speed restrictions

Accident details

Time and date	:	1300 on 2 May 2004
Location of incident	:	51° 30.3'N 000° 04.3' W St Katharine's Pier, River Thames, London
Persons on board	:	14 passengers and 3 crew
Injuries/fatalities	:	1 fatality
Damage	:	Failure to the deck structure supporting the mooring bollard in the port passenger access.

1.2 VESSEL OPERATING ROUTINE

Collins River Enterprises operates *Star Clipper* on a River Thames commuter service. The weekday service calls at Masthouse Terrace, Greenland, Canary Wharf, St Katharine's, London Bridge, City, Bankside, Blackfriars and Savoy Piers and takes approximately 25 minutes. An additional single early morning and evening stop is scheduled at Greenwich Pier. At weekends, and during public holidays, the number of stops is reduced to six, with London Bridge and Blackfriars Piers being omitted from the schedule.

1.3 NARRATIVE (ALL TIMES ARE UTC + 1)

1.3.1 Schedule prior to accident

At 0900 on 2 May 2004, the captain and mate of *Star Clipper* arrived at the overnight mooring at Greenland Pier to prepare the vessel for service. The stewardess joined them at 1000 and, following re-fuelling, *Star Clipper* sailed at 1030 to commence the usual weekend commuter service.

The first return trip was uneventful and took about 1 hour. The vessel then remained alongside Masthouse Pier from 1130 until 1210 at which time the westbound service resumed.

At approximately 1255, *Star Clipper* arrived, on schedule, at Bankside Pier. The vessel left soon afterwards with 14 passengers onboard, and made her way towards St Katharine's Pier via the Tower Bridge north bank shore arch **(Figure 1)**.

1.3.2 Effects and actions of other vessels

As *Star Clipper* entered the arch, her captain started to reduce the engine power to approximately 1000 rpm, equating to a speed of approximately 6 - 7 knots. *Star Clipper* continued to reduce speed as she passed under the arch. At the same time, the 35m, pleasure vessel *Sarpedon* was exiting the same arch. She was making a 3 - 4 knot approach onto St Katharine's Pier in preparation for picking up passengers for the Greenwich Pier service.

The 20m open topped sightseeing vessel, *Sarah Kathleen*, with 111 passengers onboard, was berthing at the eastern end of St Katharine's Pier. Her position allowed sufficient room for *Sarpedon* to go alongside St Katharine's Pier. Both *Sarpedon* and *Sarah Kathleen* are owned by Crown River Cruises based at Blackfriars Pier.

As it was high tide, a number of other small craft were also in the vicinity waiting to enter St Katharine's Dock, which is near the pier.

Conscious that *Star Clipper* is considerably more manoeuvrable than *Sarpedon*, *Star Clipper's* captain decided to overtake *Sarpedon* as he exited the arch. His initial intention was to berth just astern of *Sarah Kathleen* to leave sufficient

Figure 1

View of Tower Bridge north bank shore arch

room for *Sarpedon* to also go alongside St Katharine's Pier. However, he did not inform the mate of this. Although the overtaking manoeuvre was not unusual, *Sarpedon*'s captain was surprised that he was not informed by VHF transmission of *Star Clipper*'s intentions. The manoeuvre caused *Sarpedon* to go astern and "stand off" when about 40 - 50m from the pier.

Having noticed that *Star Clipper* was approaching, a female passenger made her way down to the pier with her husband, to join the other 30 - 35 passengers who were waiting in small groups.

At 1258, *Sarah Kathleen* was fully secured to the pier. Her captain informed his passengers that *Sarpedon* was about to come alongside for the continuation service to Greenwich. While making his public address, he turned to face Tower Bridge and was surprised to see *Star Clipper* making her final approach to the pier and *Sarpedon* "standing off". This was the first time he became aware that *Star Clipper* was in the vicinity.

In the meantime, *Sarah Kathleen*'s 45 passengers began to disembark at St Katharine's Pier.

1.3.3 *Star Clipper*'s approach to St Katharine's Pier

At 1259, having overtaken *Sarpedon, Star Clipper* made the final approach to St Katharine's Pier. Her mate was standing in the port passenger access with the mooring rope in his hand **(Figure 2)**. The stewardess was inside the passenger cabin. Both port and starboard cabin doors, which gave access to the passenger embarkation platforms, were closed.

The engine power was reduced, and the captain manoeuvred the vessel with the water jet controls to make a normal, shallow approach, with the port bow slightly towards the pier. As the vessel neared the pier passenger gate, almost all ahead way had been taken off.

When *Star Clipper* was about 3 metres from the pier, her mate threw the eye of the polypropylene mooring rope over a pier bollard. Content that the eye was secure, he then took a "running turn" around the port after stainless steel mooring bollard, located in the port passenger access recess. (The arrangement at **Figure 3** shows the position of the starboard bollard, which was identical to that on the port side prior to failure.) The "turn" around the bollard allowed the mate to let rope out as the vessel aligned with the pier passenger gate.

Figure 2

Port passenger access - mate's position for coming alongside

Figure 3

Passenger access - stainless steel MkIII bollard

When the rope was over the pier bollard, *Star Clipper'*s captain, mindful that *Sarpedon* wanted to come alongside the pier, told the mate that they should go to the next pier passenger gate to give *Sarpedon* enough space to berth. However, the mate reported on the talk-back voice communications unit, that he already had a rope on the pier bollard. The captain confirmed this using his bridge wing mirrors, which provided a clear line of sight to the passenger access platforms. He therefore decided not to move the vessel further forward as originally planned. Positions of vessels and pier gates are shown in **Figure 4**.

Figure 4

Diagramatic representation of the relative positions of vessels and casualty at the time of the accident (Not to scale)

1.3.4 Bollard failure

When *Star Clipper* was about 1.5m from the pier, the mate judged that about 2.6m of slack rope was required to allow her to align with the pier passenger gate. He secured the rope onto the vessel's bollard with a "pin hitch" **(Figure 5)**. This action is known as the "fetch up".

Meanwhile, the captain had the propulsion water jet controls in the "just ahead" position as indicated by two bars on his positional LED indicators with his engines set at about 800 rpm. This setting provided sufficient power to bring the vessel alongside and to counteract the wash from the engines of *Sarah Kathleen,* which was moored ahead. The mate, having secured the rope, dropped the free end to the deck and prepared to open the passenger gates ready for disembarkation.

Figure 5

Mooring rope 'pin hitch' arrangement

At 1300, when *Star Clipper* was just under 1m from the pier edge, the mooring bollard and supporting insert plate **(Figure 6)** were ripped from the deck and catapulted over the 1.1m safety fence, into a group of waiting passengers. The mooring rope, having become detached from both the pier and vessel's mooring bollards, was reported to have "snaked" through the air, and landed among the passengers. At the same time, the mate looked down at the passenger access platform and saw a hole where the bollard had previously been **(Figure 7)**. He then looked down the pier and saw a female passenger laying approximately 2.13m from the pier bollard position. She was surrounded by other waiting passengers. As the bollard failed, the vessel moved about 1m along the pier where the captain held her in position using her engines.

As soon as he saw the casualty, the mate rushed over to her. He saw that she was badly injured and concluded that the bollard had hit her. The mate did not notice the position of the bollard or mooring rope at that time. Now in shock, he returned to *Star Clipper* immediately, and informed the captain of the situation.

The captain contacted Woolwich Radio on VHF channel 14 requesting the attendance of an ambulance. Afterwards, the mate secured the vessel alongside with a replacement rope. He provided towels for the injured lady, as requested by her husband, and attended to his passengers.

Figure 6

Displaced stainless steel
mooring bollard and insert plate

Figure 7

MkI bollard base plate remains

Position of displaced bollard

1.3.5 Actions by *Sarah Kathleen* and *Sarpedon*

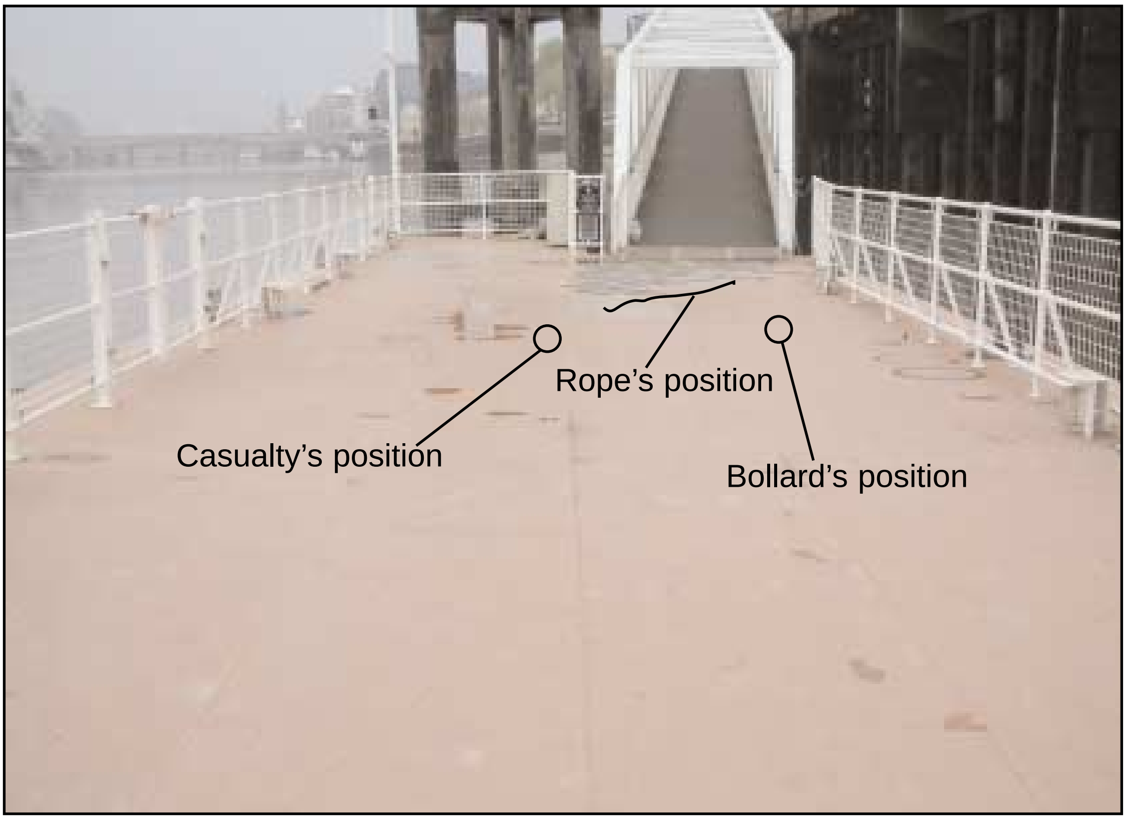
At the time the bollard failed, the mate of *Sarah Kathleen* was assisting with the disembarkation of passengers when he heard, what he described, as a "bang". He ran to the injured lady. Realising she had suffered a severe head injury, he advised that she should not be moved. He then ran back to his vessel and alerted the captain, who in turn also tried to contact Woolwich Radio. Unable to do so because of other communications traffic, he contacted the nearby PLA harbour services launch, *Westbourne,* and requested the attendance of an ambulance. *Sarah Kathleen'*s mate then returned to the group surrounding the injured lady and informed them that an ambulance was on its way. *Sarah Kathleen* then completed embarking passengers and left the pier at about 1305.

Sarpedon immediately came alongside the pier, ahead of *Star Clipper*, and transferred passengers as quickly as possible in an attempt to help clear the area. She then proceeded downriver at 1307.

1.3.6 Immediate post-accident actions

*Westbourne'*s crew, now aware of the accident, attended to the casualty with two off-duty trauma nurses who were also on the pier. The coxswain noted that *Star Clipper'*s bollard and mooring rope were laying close by the casualty **(Figure 8)**.

Figure 8



Approximate position of casualty, bollard, and rope

London CG alerted the Tower lifeboat at 1304. The lifeboat arrived on the scene at about 1306 and two of its crew immediately helped to assess the unconscious lady's condition. No pulse could be detected and the lady had stopped breathing. The trauma nurses attended to the lady's head injury as the lifeboat crew began CPR whilst waiting for the arrival of the medical emergency services. Other members of the lifeboat crew attended to *Star Clipper'*s crew and waiting passengers, a number of whom were showing signs of shock.

At 1307, now relieved by the lifeboat crew, the coxswain of *Westbourne* helped to clear the pier of passengers via the northern ramp, which by now had been opened by security staff. He then closed the pier to navigation as advised by Woolwich Radio. His final action was to obtain an alcohol breath test from the captain and mate of *Star Clipper.* Both results proved negative.

The LAS paramedics arrived on the scene at 1311, Metropolitan police officers started to arrive at 1317, and the HEMS doctor arrived, by road, at 1318.

The Metropolitan Police MSU arrived at 1344, having been alerted of the accident at 1316 while at Barking Creek. On arrival, the MSU advised the police shore units, liaised with Woolwich Radio and the PLA, and attended to the mate of *Star Clipper* who was still in shock.

While the medical teams attended to the casualty, the police officers cordoned off the area. They screened off a section of the pier to provide a degree of privacy, and gathered witness statements. The police inspector, who was the duty officer of Tower Hamlets Borough, arrived at the pier at 1328. A further alcohol breath test was then obtained from the captain and mate of *Star Clipper.* Again, the results were negative.

At 1355, the medical team decided to transfer the casualty to the nearby Royal London Hospital. Despite the best efforts of the medical team, she died at 1434.

At about 1445, and following discussions between the Metropolitan Police, HSE Director for London, and the MAIB, it was agreed that the MAIB would take primary responsibility for the investigation.

1.4 MCA POST-ACCIDENT ACTIONS

1.4.1 MCA Prohibition Notice

On 2 May 2004, as a result of the defective bollard, the MCA issued a Prohibition Notice withdrawing the passenger certificate for *Star Clipper*. On 3 May 2004, an addendum was issued to the Notice suspending the prohibition until 7 May 2004 dependent upon a number of conditions.

The conditions banned the use of the amidships (passenger access) bollards and advised other safety measures to be adopted to safeguard both crew and passengers. They also required a risk assessment to be undertaken on the revised mooring arrangements. Details of the proposed structural changes to be undertaken prior to the re-instatement of the midships bollards were also required. A copy of the Prohibition Notice and Addendum is at **Annex A**.

1.5 *STAR CLIPPER* – CREW PARTICULARS

1.5.1 Captain

The captain held a full Waterman's licence (No 73339) which was gained in May 1994. He also held a Large Passenger Vessel endorsement to his licence, granted by Waterman's Hall in March 1998. An experienced mariner, he worked with his previous employer, a River Thames pleasure boat company, for 9 years. He also worked on the *Clipper* vessels when this company operated on the River Thames as part of the now defunct London River Bus Company.

The captain joined CRE in January 2004 when the company's operations manager assessed his suitability for the position of captain during a 2 week training period.

1.5.2 Mate

The mate has worked for CRE for 2 years. The company is sponsoring him to undertake his 5-year Waterman's apprenticeship. In March 2004 he gained his PLA Grade 2 qualification in seamanship and chartwork, in addition to the mandatory sea survival, VHF, first-aid and fire-fighting qualifications. On 24 May 2004, he was awarded his Provisional Waterman's Licence, which allows him to be in charge of vessels carrying no more than 12 passengers.

1.5.3 Stewardess

The Polish stewardess has worked for CRE for 4 months. She had limited marine experience, but received appropriate training and assessment before undertaking her role.

1.6 DESCRIPTION OF VESSEL

Star Clipper is a 23.65m, Hydro Cat class catamaran built in 1992. She is a Class V passenger vessel and is certified to carry a maximum of 62 passengers, with a minimum of 2 crew in daylight hours and 3 crew at night.

The twin GRP composite hulls are connected by two aluminium cross beams which support the aluminium passenger cabin. Each of the hulls is fitted with a Scania DS1-11 diesel engine that drives a Rival Calzona IRC39D water jet propulsion unit. Each water jet produces 250kW at 1800 rpm.

The main engine alternators charge two banks of 24V batteries, each of 200 ampere hours. One bank provides normal vessel electrical services, the second battery bank is used for emergency supply purposes**.**

The bridge is accessed from the passenger cabin area and has a single seat for the captain. The general arrangement of the vessel is at **Figures 9** and **10)**. The waterjet controls, electro-hydraulic and manual hydraulic steering controls, engine and gearbox controls are designed for single person bridge operation. The layout of the controls is shown at **Figures 11** and **12**.

Figure 9

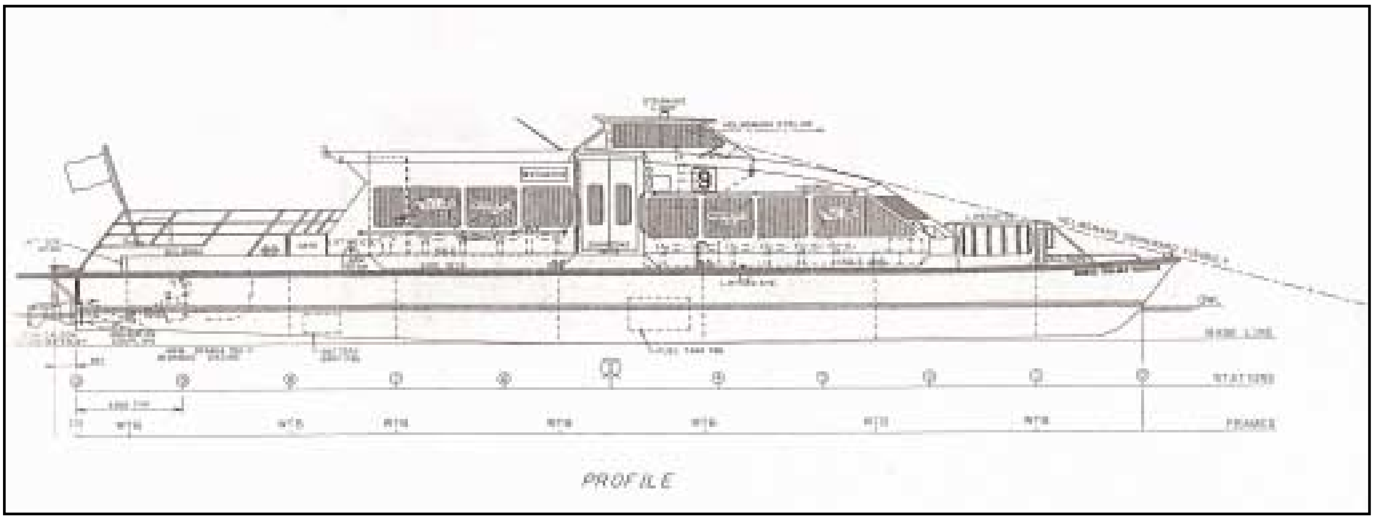
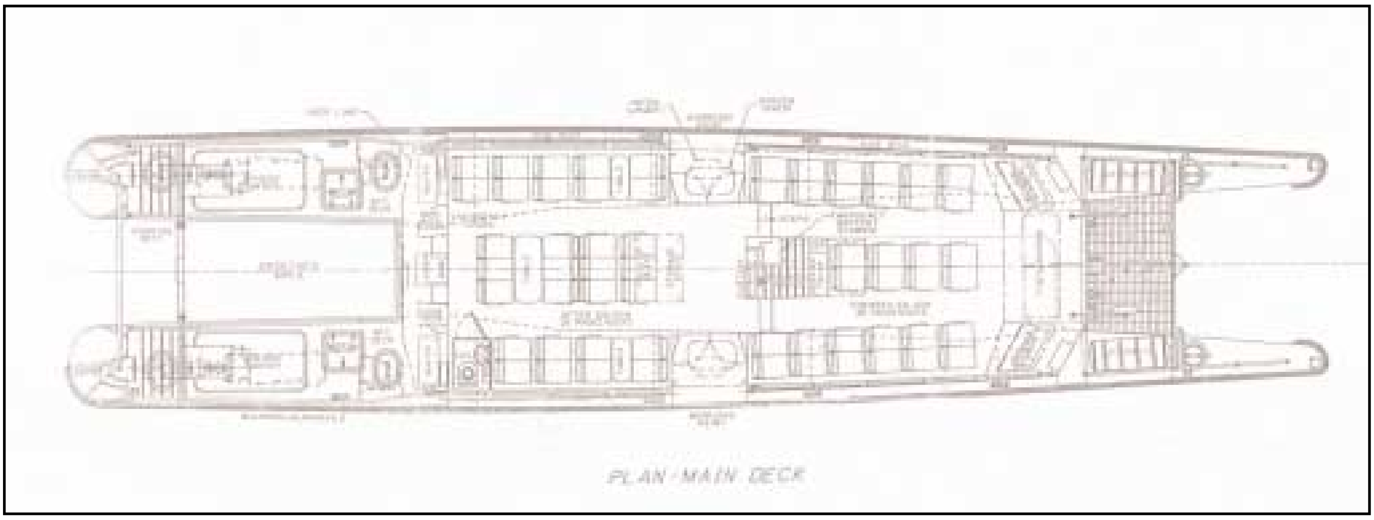
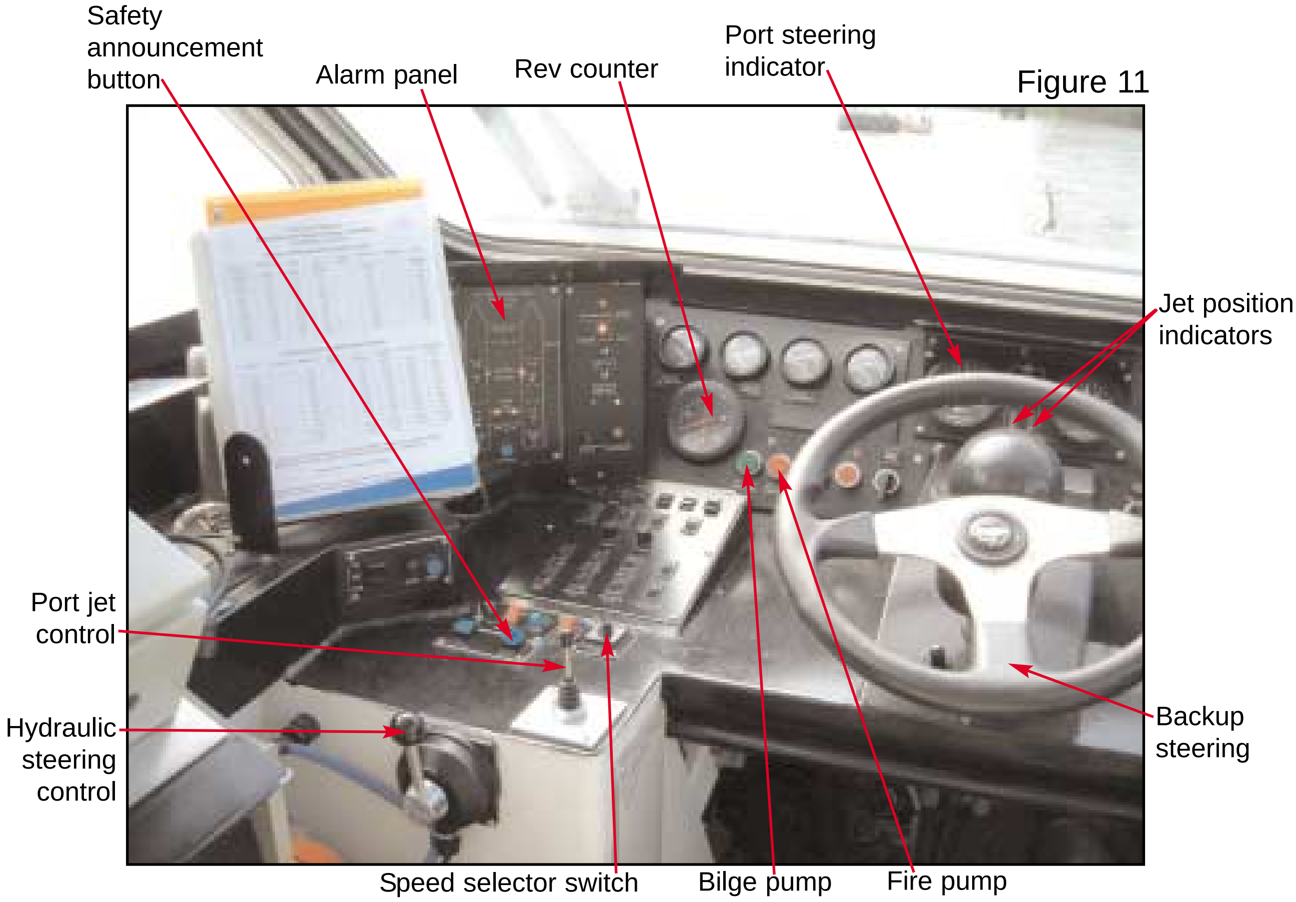


Figure 10



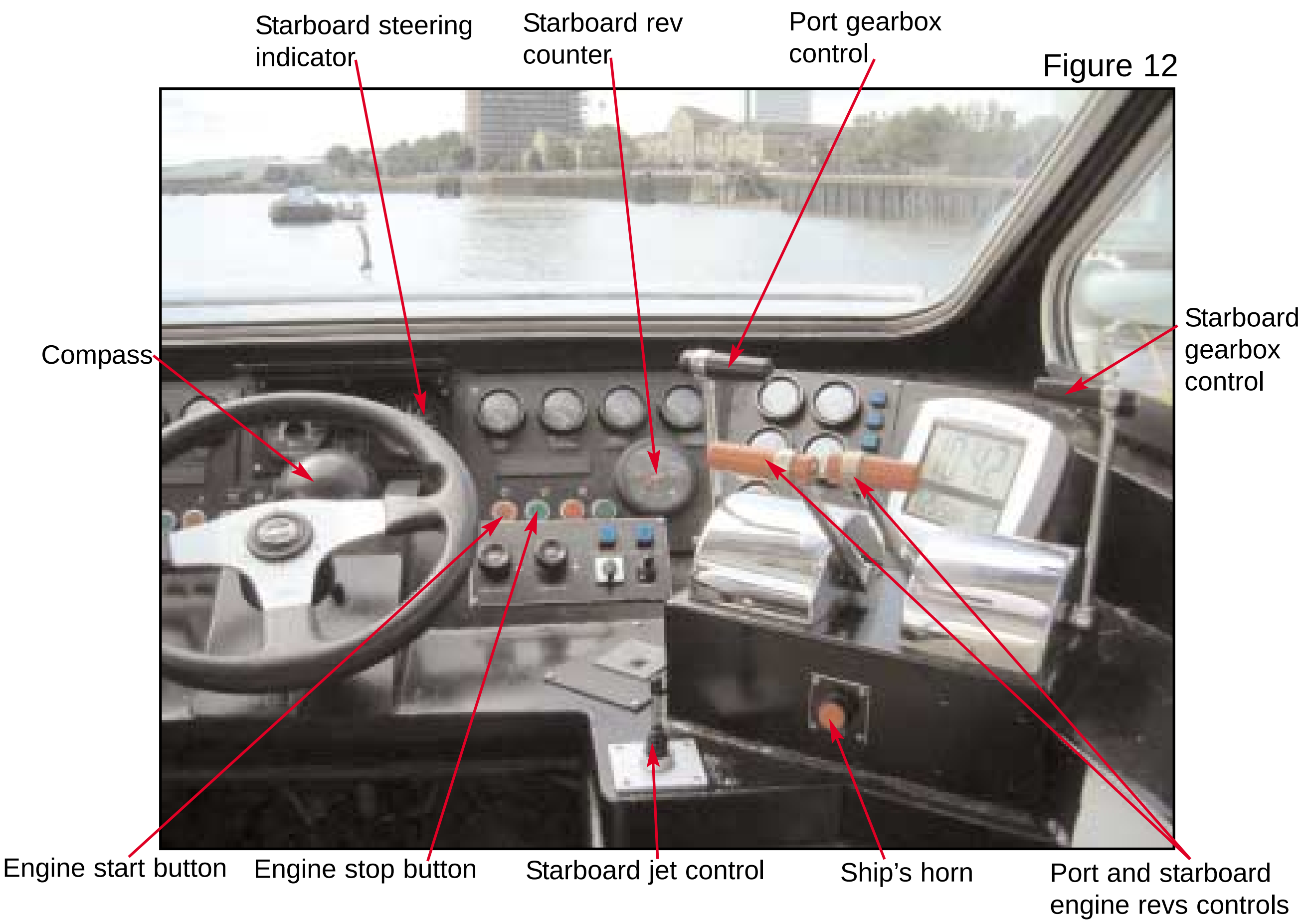
Star Clipper - general arrangement

Figure 11



Port side bridge controls

Figure 12



Starboard side bridge controls

1.7 COMPANY AND VESSEL HISTORY

1.7.1 Operating company history

Collins River Enterprises (CRE) Ltd, operating as Thames Clippers, was established in May 1999 and has approximately 40 employees. The first of the vessels, *Storm Clipper*, was purchased in February 1999 and was refitted for the initial six stop Thames commuter service between Greenland and Savoy Piers.

Two other vessels of the same class were subsequently purchased and refitted, *Sky Clipper* in September 2001 and *Star Clipper* in July 2003. With the purchase of these vessels, the commuter service was extended to operate between Masthouse Terrace and Savoy Piers.

The company also owns and operates *Hurricane Clipper,* a large 220 passenger commuter service catamaran. A fifth vessel, managed by, but not owned by, the company, operates between Hilton Docklands and Canary Wharf piers.

1.7.2 Founder owner

The founder and owner of CRE is also the company's marine operations director, and has been working on the River Thames for 19 years. He is a fully licensed Waterman and has a number of years' experience as a skipper on tugs and on his own company's catamarans.

1.7.3 Vessel history

Star Clipper, Storm Clipper and *Sky Clipper* were all built in 1992, by FBM Marine Ltd, at Cowes on the Isle of Wight. The vessels were designed for service with the London-based River Bus Partnership, but they saw limited service with that company. Two of them were delivered over a 6-month period and the third was eventually delivered 1 week before the company ceased trading. At that time *Star Clipper* was named *Conrad Chelsea Harbour.*

All three vessels, which were by now owned by Barclays Bank, were then "laid up" in St Katharine's Dock, London. Serco Denholm Ltd chartered the vessels in late 1996 for service in Devonport Naval Base. *Conrad Chelsea Harbour* was renamed *SD9* and was acquired by Serco Denholm Ltd on 30 December 1996 for passenger service within Devonport Naval Base. *SD9* was in use for about 5 years before a further period of "lay up". The vessel was sold to CRE on 12 September 2002.

Following repairs in both Devonport and at CRE's workshops at Greenland Pier, London, *SD9* was renamed *Star Clipper* and finally entered service with CRE in October 2003.

1.7.4 Classification society

The vessel was classed with Lloyd's Register throughout the period that Serco Denholm Ltd chartered *SD9*. None of the *Clipper* vessels is currently classed with a classification society; they operate under MCA rules and surveys.

1.7.5 MCA inspection

Under CRE ownership, *Star Clipper* was first surveyed for passenger service on the River Thames, in October 2003 by the MCA's Orpington Office. A short term Passenger Safety Certificate was issued valid until 31 December 2003. A second short term certificate was issued on 23 December valid until 31 January 2004. The vessel was subsequently inspected out of the water on 2 February 2004 and surveyed on 18 February, and a full passenger certificate was issued. No defects were identified with the mooring bollard arrangements on any occasion.

A copy of the vessel's Passenger Certificate and Domestic Safety Management Certificate is at **Annex B**.

1.8 WEATHER CONDITIONS

The weather conditions at the time of the accident were good. The tide was slack with high water at London Bridge predicted at 1256 with a height of 6.5m; actual high tide occurred at 1302 with a height of 6.57m. Visibility was good, and although there was negligible swell, the wash from several small craft disturbed the river surface. The wind was at force 1 from a direction of 270°.

1.9 ST KATHARINE'S PIER

1.9.1 General

St Katharine's Pier is situated 100m from the eastern side of Tower Bridge, on the north bank of the River Thames. It is usually unmanned and has been owned by the St Katharine's Investment LP since March 2004. The day-to-day management of the pier, including maintenance requirements, is undertaken by the St Katharine's Dock harbourmaster. A risk assessment was held for pier operations under the previous owner's tenure, but it was in need of review.

1.9.2 Layout

The pier is 60m long and 6.5m wide. A 1.1m high, steel mesh safety fence is fitted around the perimeter, 0.5m from the edge of the pier. Twelve mooring bollards, 28cm high and 22cm in diameter are fitted to the riverside of the pier, outside the safety fencing. There are two single and two double passenger access gates positioned along the riverside length of the pier and two double passenger access gates on the bank side. The pier sides are protected by rolling, cylindrical, angular rubber fendering.

Two ramps provide access to the pier. The western ramp is the normal passenger access and this is locked at about 2100, after the last routine river service call. The northern ramp is normally locked because of the acute angle it assumes at low tide and the risk this poses to passenger safety. The layout of the pier is shown at **Figure 13**.

1.9.3 CCTV

A CCTV camera is situated on the top of the pier centre support pillar. The camera is controlled and the images recorded by the security department of the nearby International House building on St Katharine's Way. The St Katharine's Dock harbourmaster cannot monitor the camera images.

At the time of the accident, the camera was pointing towards St Katharine's Dock. It was not until 1307 that the security department in the International House building was alerted to the accident. The camera was then redirected at St Katharine's Pier.

A further CCTV is fitted on the centre span of Tower Bridge, but this cannot scan St Katharine's Pier.

1.10 DESCRIPTION OF FAILED MOORING BOLLARD

1.10.1 General observations

The stainless steel mooring bollard was recovered by the Metropolitan Police and was still connected to the 6mm aluminium insert plate by 6 x M10 stainless steel bolts and associated washers, nuts and lock nuts. The arrangement had been repaired, and the weld securing the insert plate to the supporting structure had failed. Weld material with signs of porosity was found on the edges of the insert plate.

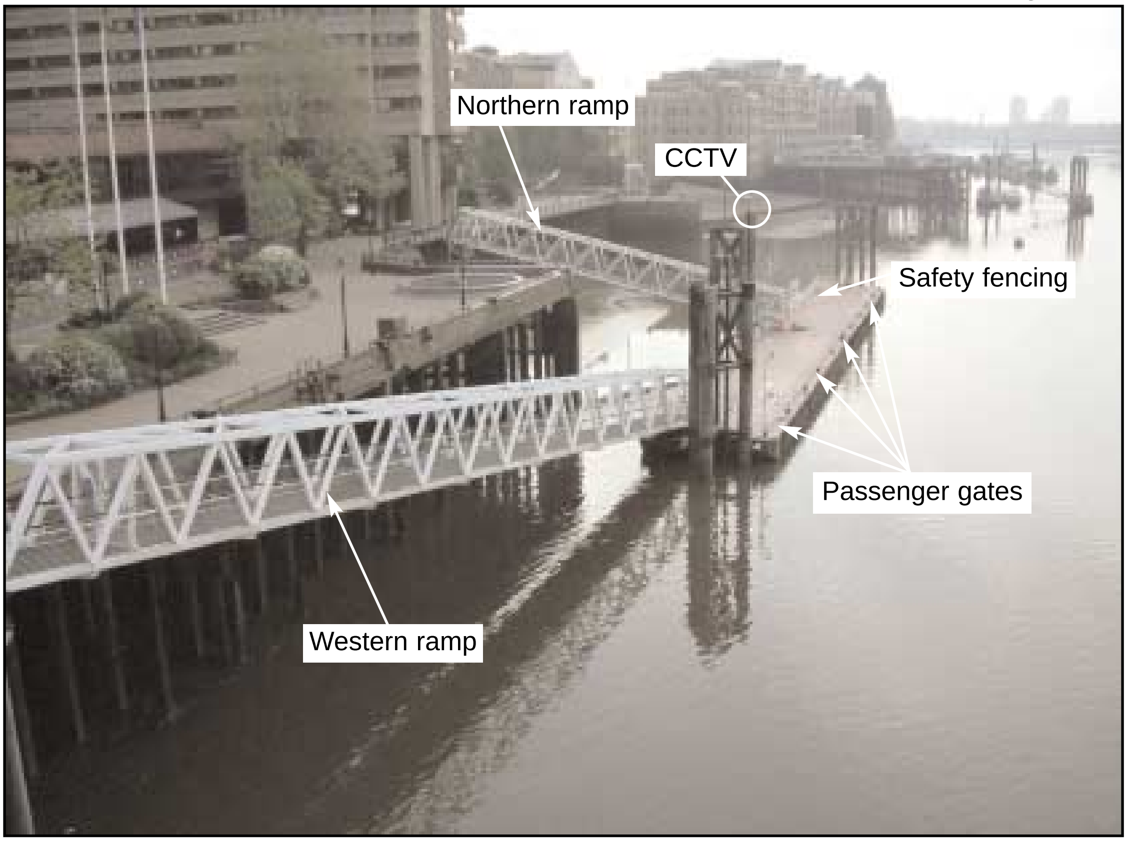
There was also considerable distortion of the bollard stainless steel base plate and aluminium insert plate. The latter had suffered the greatest deformation. There did not appear to be any damage to the bolts, bollard, vertical and horizontal pins, or associated pin fillet welds. However, all but one of the washers had suffered severe deformation.

Also evident were areas of white paint at the upper part of the vertical pin, and an area of red paint on one corner of the insert plate **(Figure 14)**.

1.10.2 Dimensional information

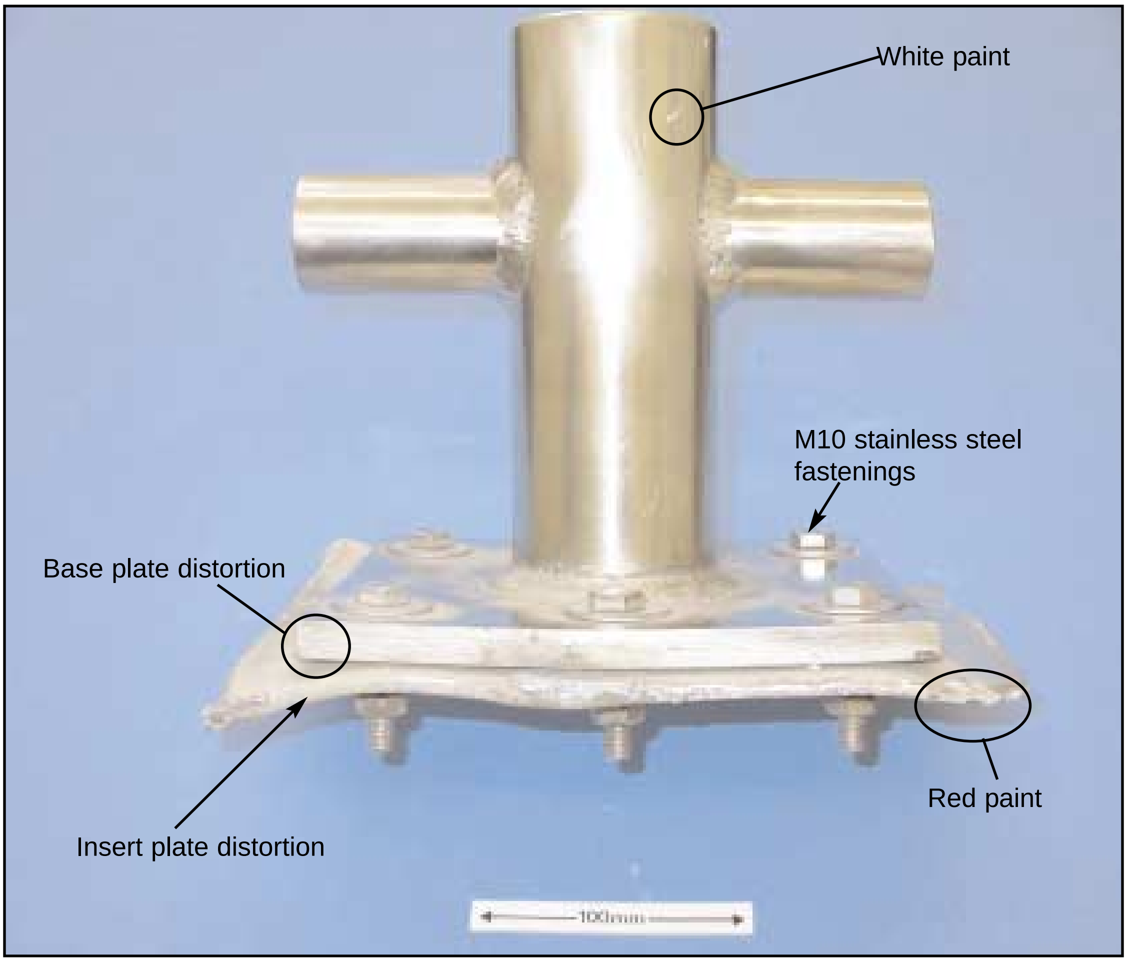
The combined weight of the bollard, insert plate and fixtures was recorded as 14.169kg. The vertical pin is 76.1mm in diameter and 200mm high. The horizontal pins are 44.4mm in diameter and are positioned 130mm up from the base plate.

Figure 13



Layout of St Katharine's Pier

Figure 14



Location of red and white paint, fastenings and insert plate distortion

1.11 HISTORY OF MOORING BOLLARD CHANGES

1.11.1 Build

At the time of build, none of the three *Clipper* vessels was fitted with bollards in the passenger accesses. The original configuration had four stainless steel bollards fitted to each hull. None of these fittings, all of which remain, has exhibited signs of failure.

For ease of identification, the bollards fitted to the passenger access areas are given MAIB designated **Mk** numbers as follows:

MAIB MARK (Mk) IDENTIFIER	DESCRIPTION
Mk I	Hollow aluminium bollards with four point nut and bolt fastenings, fitted during Serco Denholm charter
Mk II	Hollow stainless steel bollards with 6mm base plate and four point nut and bolt fastenings, fitted by CRE.
Mk III	Hollow stainless steel bollards with 10mm base plate and six point nut and bolt fastenings, fitted by CRE.
Mk IV	Solid stainless steel bollards with 12mm base plate and six point nut and bolt fastenings, fitted by CRE.

Table 1

1.11.2 Serco Denholm Ltd charter

While under Serco Denholm Ltd charter (paragraph 1.7.3), the crews found access from the passenger platform of the three *Clipper* vessels to the forward bollards extremely difficult, particularly during inclement weather **(Figure 15)**. To overcome this, four **Mk I** bollards were fitted in the passenger access areas **(Figure 16)**. No changes were made to the 3mm aluminium supporting structure. During this time, the bollards were only used during passenger movements. The original fit bollards continued to be used for overnight mooring.

While under Serco Denholm ownership, the vessels were classed under Lloyd's Register. LR Rules and Regulations for the Classification of Ships, Part 3, structures, section 7.5.6 require that: "*suitable means are provided to ensure that mooring lines are adequately secure on board ship, and the importance of ensuring that the securing arrangements, including the supporting hull structure are efficiently constructed and adequate for the intended loads".*

It is possible that fitting of these bollards, with the likelihood of their failure rather than their surrounding structure, due to excessive loads, was the considered means of satisfying this requirement.

Figure 15

Showing the difficult access to forward bollards

Figure 16

Aluminium bollard showing distortion to base plate and vertical pin

View of MkI hollow aluminium bollard

Very few of the engineers who were involved with the vessels, still work for Serco Denholm Ltd. However, Serco Denholm's technical staff confirmed that the bollards were designed to crumple under stress loading to protect the passenger platform, although no drawings or calculations could be located to support this.

Lloyd's Register has no records of the changes made to the bollard arrangement and they were not consulted regarding their suitability to withstand the 'in service' loads.

1.11.3 CRE ownership

On taking ownership of *Sky Clipper,* CRE replaced the **Mk I** aluminium bollards fitted to the passenger access areas, some of which had already failed **(Figure 17)**. Two **Mk II** bollards were fitted to the after end of the access as it was found that the forward two were not required for the River Thames operation. However, within 6 weeks of service, the weld at the base of the bollards' vertical pin began to fracture and the base plates deformed. The bollard design was subsequently changed, and the defective bollards were replaced with **Mk III** bollards. The increase in base plate thickness resolved the base plate distortion, but the bollard vertical pin still suffered deformation.

Figure 17

Failed MkI bollard

When CRE took delivery of *Star Clipper,* the vessel was still fitted with four **Mk I** bollards. Between October 2003 and January 2004, when the vessel was first in service, the port forward bollard was damaged while alongside at an overnight mooring. Some time between December 2003 and January 2004, the two after **Mk I** bollards were replaced with **Mk IV** bollards. The two forward bollards, which included the damaged one, were left in place.

1.12 OWNERS' RESPONSIBILITY TO REPORT DEFECTS/FAILURES

The responsibility for owners of vessels certified by the MCA to report failures and changes to structure and equipment, is stipulated in the following:

- Statutory Instrument 2000 No 1334, paragraph 8 (1) (b) and (c) which states:

Responsibilities of owner and master

(b) after any survey of the ship required by these Regulations has been completed, no change shall be made in the structural arrangements, machinery, equipment and other items covered by the survey, without the approval of the appropriate Certifying Authority, except by direct replacement and

(c) whenever an accident occurs to a ship or a defect is discovered, either of which affects the safety of the ship or the efficiency or completeness of its life-saving appliance or other equipment:

(i) it is reported at the earliest opportunity to the appropriate Certifying Authority ……..

- Notes affixed to the Passenger Certificate and Safety Management Certificate dated 18 February 2004 **(Annex B)**.

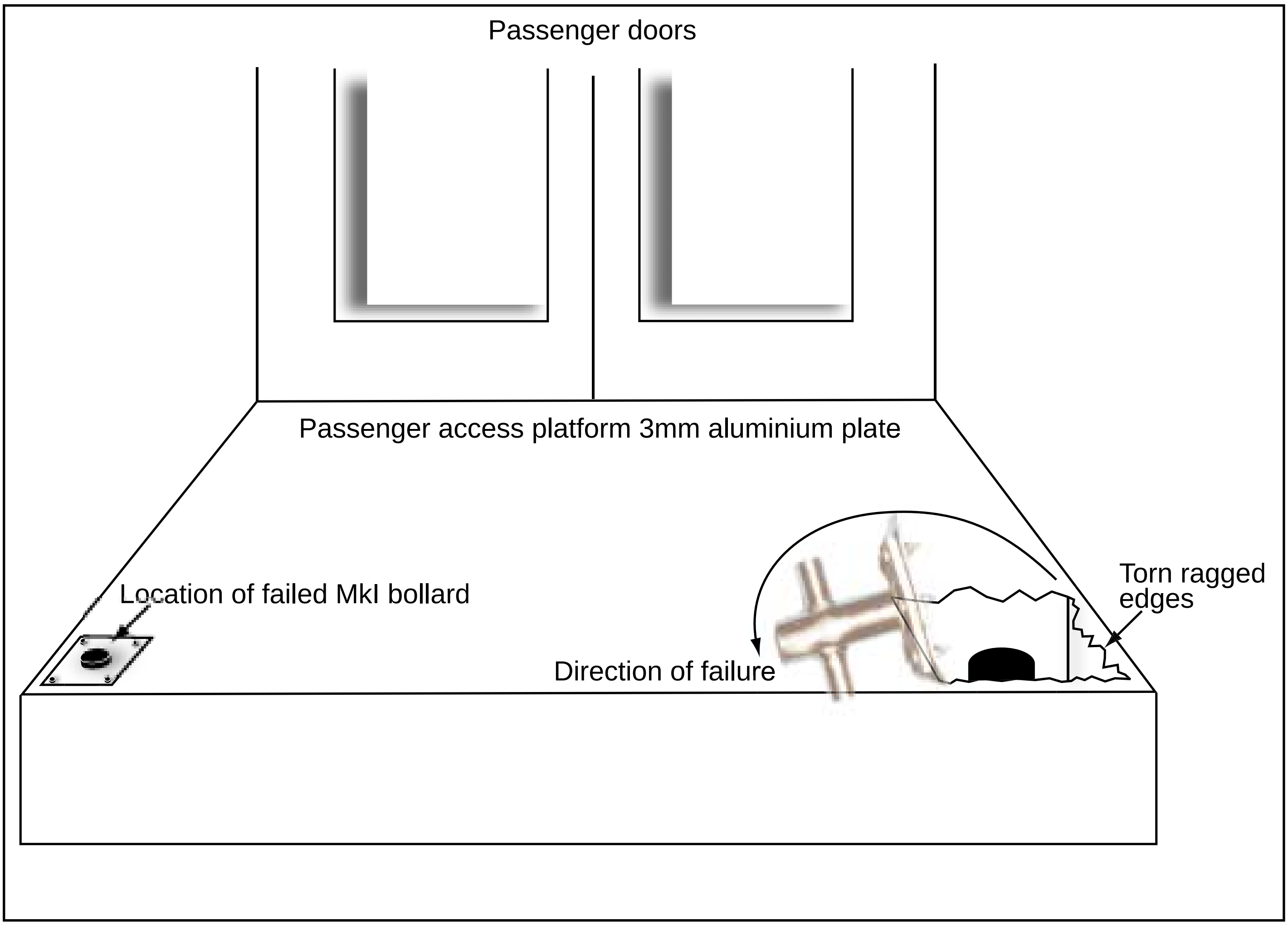
1.13 BOLLARD REPAIRS FOLLOWING FAILURE ON 9 APRIL 2004

1.13.1 Background

On 9 April 2004, the port after **Mk IV** type bollard in *Star Clipper*'s passenger access was torn from the deck. Whilst leaving a pier, the eye of the mooring rope caught on both the pier bollard and the vessel's bollard. As the vessel went astern, force was exerted onto the after face of the vessel's bollard, tearing up three sides of the supporting 3mm aluminium deck checker plate **(Figure 18)**.

CRE commissioned Alweld, of Rainham in Kent, a company well known to them, to conduct the repair. Alweld had, over a three year period, completed a wide range of work on the 'Clipper' vessels to the satisfaction of CRE, including the fabrication of the **Mk II**, **Mk III** and **Mk IV** bollards. Alweld was considered by CRE to be intimately acquainted with the three 'Clipper' vessels and competent to conduct routine repairs.

Figure 18



Damage to bollard arrangement sustained on 9 April 2004

The marine operations director of CRE initially required that the repair be completed by 1030 on 12 April. Meeting this deadline would enable the vessel to conduct her normal weekday commuter service following the reduced bank holiday weekend schedule. However, the deadline was revised to 1030 on 10 April to coincide with the contractor's holiday plans.

Alweld advised CRE that they did not hold any aluminium chequer plate that matched the passenger platform material. CRE stated that it was not necessary to use checker plate for the repair, despite the non-slip properties of this material. This was because the replacement base plate would not be directly in the pedestrian area. CRE required that a thicker, unspecified insert plate was to be used, as they considered it would provide better support than the original checker plate. This was the extent of the advice given to the repair contractor. No direction was given to Alweld in respect of insert plate material selection, plate preparation or welding procedures.

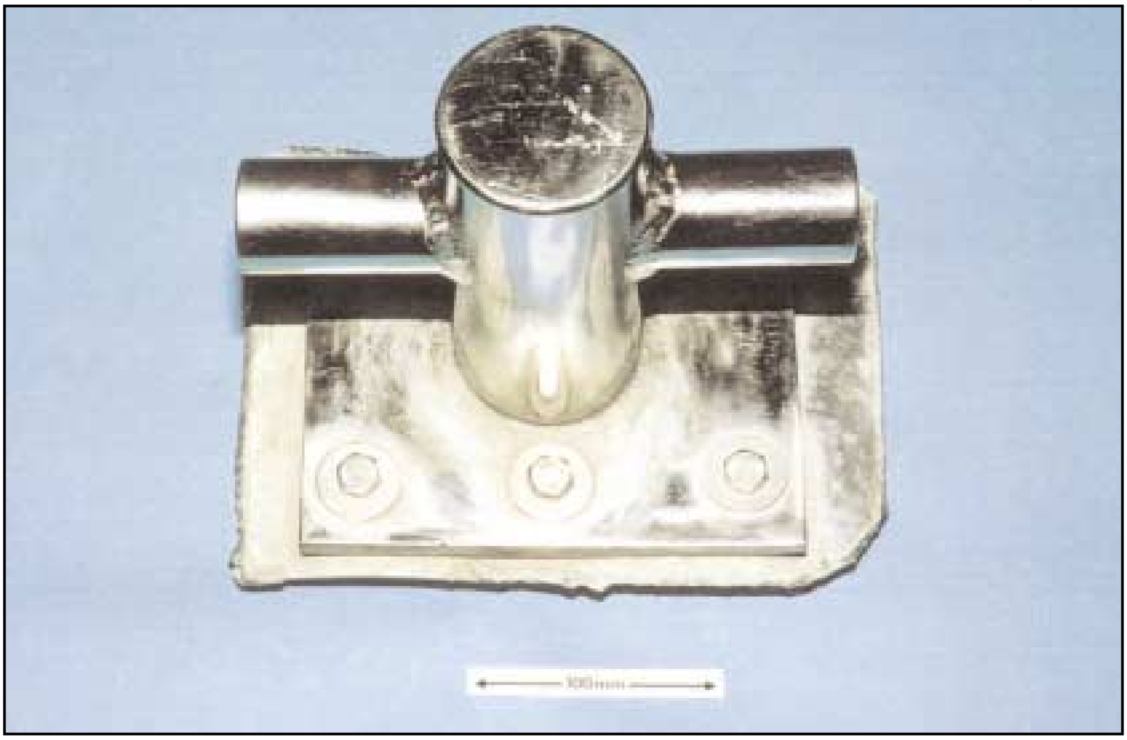
CRE did not inform MCA of the bollard failure, or of the repair specifications. No professional advice or opinion was sought on the repair proposal or material selection.

1.13.2 Preparation for repair

By the time the Alweld representative arrived on site, CRE engineers had already removed the bollard from the damaged 3mm aluminium deck plate and had hammered down the edges of the torn deck section. The Alweld employee fitted the bollard to a thicker, 6mm aluminium mounting plate, which was drilled and secured to the bollard base plate with 6 x M10, 316 stainless steel bolts with washers, nuts and locking nuts **(Figure 19)**. The damaged deck area was dressed to facilitate fitting of the insert/doubler plate, which was cut to size on site.

Other than debris and paint removal, and grinding off the raised sections on the checker plate, there were no other pre-weld preparations.

Figure 19



Bollard and insert plate fastening arrangements viewed from inboard side

1.13.3 Weld repair

The repair was carried out by the son of Alweld's founder/owner. He used the TIG welding process, which included the use of 4043 low strength aluminium silicon type filler rod. The electrical current used during the process varied between 150 and 200 amperes.

The weld repair was neither supported by any weld procedure, nor was there any oversight or effective quality assurance checks in place to verify the integrity of the weld repair. CRE's marine operations manager and fleet safety manager visually checked the repair on 10 April. They stated that they were inexperienced in welding techniques, but thought it to be a satisfactory repair. This belief was based on the amount of weld material evident.

The owner of Alweld visually examined the weld on 13 April, while the vessel was in service. He raised no concerns about the quality of the repair.

1.14 ALWELD - FABRICATION AND WELDING COMPANY

1.14.1 Background

Alweld was established in 2001 and are advertised as welding and fabrication specialists. The owner had previously been employed as a welder/fabricator manager for the London Underground Jubilee Line Extension. He stated he had held a Lloyd's Register welding qualification, but this had lapsed about 10 years before the accident.

The company employees comprise the founder/owner, who has 30 years experience in the welding and general fabrication field; his son, a welder and general fabricator; and the owner's wife who acts in an administrative role. The company occasionally sub contracts some work out.

1.14.2 Welder's experience

The owner's son conducted the repair. He had 2½ years' experience in welding stainless steel, mild steel and aluminium. He has also undertaken some general fabrication work. His experience has been gained from a combination of "on the job training" conducted by his father, and self-tuition. He had no formal welding training and held no welding qualifications.

Prior to starting the repair, the welder sought advice, by telephone, from his father who was on holiday in France. He outlined his intentions for the repair and these were agreed with his father.

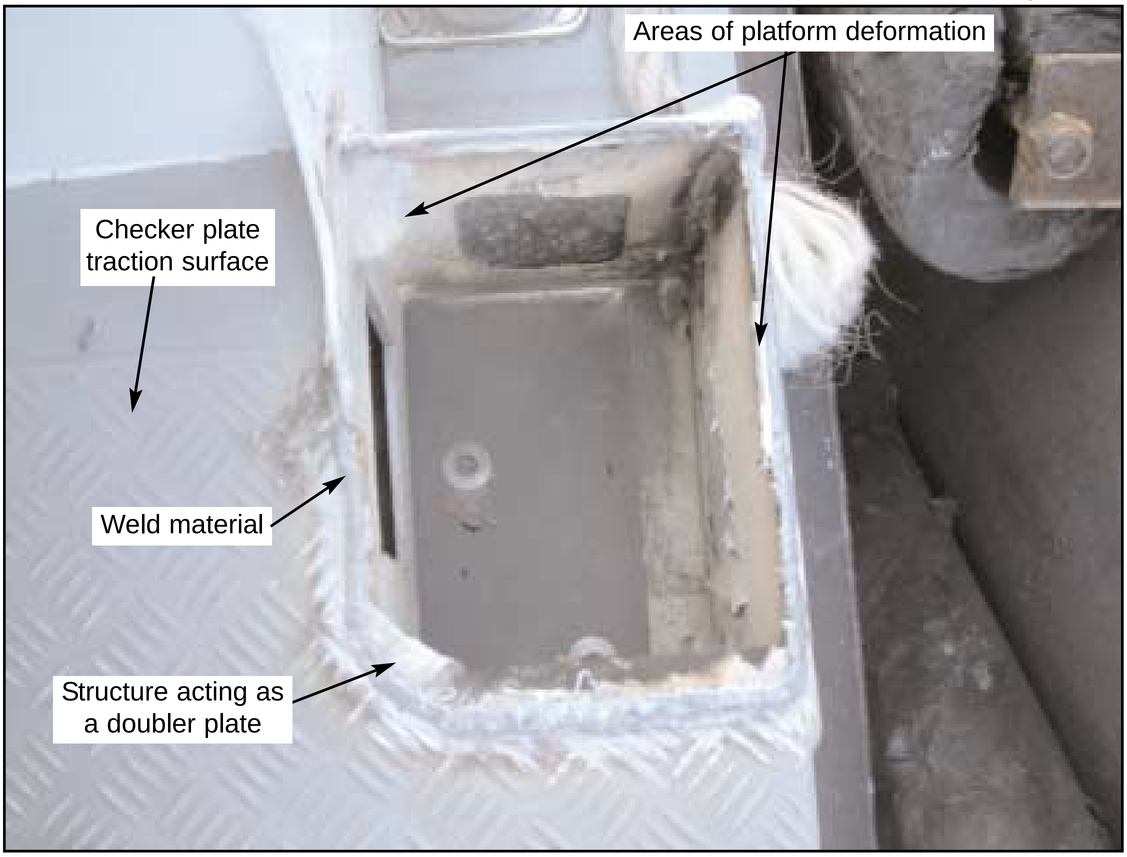
1.15 *STAR CLIPPER*'S PASSENGER ACCESS PLATFORM

1.15.1 Structure

Both port and starboard passenger access platforms are manufactured from 3mm aluminium plate, type 5083, to BS 1470,1987 grade. The passenger platform arrangement is at **(Figure 20)**.

The platforms are constructed in a traditional "box" configuration made up of transverse and longitudinal flat aluminium plates. The construction is finished with a 3mm aluminium checker top plate, providing a traction surface for passengers and crew. The platforms were not designed or constructed to support mooring bollards, and were not designed to withstand the stresses imposed by routine use of the bollards.

Figure 20



Passenger access platform - structural arrangement

1.15.2 Bollard mounting area damage

Initial examination of the damaged structure confirmed the insert plate fillet weld had failed. Much of the fillet weld was still in evidence, both on the vertical structure and on the checker plate. There was no evidence of insert plate parent material remaining. It was noted that the aluminium checker plate supported the forward end of the insert plate. This effectively formed a doubler plate arrangement at this interface.

The 3mm aluminium under floor supporting structure had also suffered severe deformation.

1.16 MOORING ROPE

According to BS EN 699:1995, the mooring rope is defined as a 3-strand hawser laid polypropylene rope. The rope had a single eye, it was 24mm in diameter and 6.5m long, with a stated minimum breaking force of 79.65kN. During tensile testing, it was found that the rope's actual breaking force was 65.04kN.

CRE received the rope on 16 March 2004. It is not known when it was first used. At the time of the accident, the rope was defect free, with the exception of some minor mooring-related abrasions to the inner face of the eye.

1.17 INDEPENDENT REPORTS

The preliminary findings of the MAIB investigation indicated there was a need for specialist assistance to determine the cause of the bollard failure, and to ascertain how the bollard was catapulted clear of the pier river side safety fence and struck the casualty.

The MAIB commissioned tests and examinations of:

- The bollard, bollard insert plate, weld and support structure.
- The polypropylene mooring rope and related possible bollard trajectories.
- Paint sample deposits on the bollard, insert plate and from the accident site.

1.17.1 Bollard, bollard insert plate, weld and support structure

The Test House (Cambridge) conducted a detailed analysis of the bollard insert plate welding and supporting structure. The report concluded that the failure occurred through shear stress overloading of the recently completed insert plate fillet weld.

Relevant extracts of the report are included at **Annex C**.

1.17.2 Polypropylene mooring rope and related possible bollard trajectories

Tension Technology International Ltd :

- Established load elongation characteristics of the mooring rope.
- Developed the three most likely scenarios for the bollard trajectory.

No significant defects were identified with the rope. The breaking strength of the rope was found to be 65.04kN corresponding to an elongation of 14.97%.

Throughout the various trajectory calculations it is likely that the vessel's speed was not less than 0.55km/hr (0.3 knots) and not more than 2.32km/hr (1.3 knots).

Relevant extracts of the report are included at **Annex D**.

1.17.3 Paint sample deposits on the bollard, insert plate and from the accident site

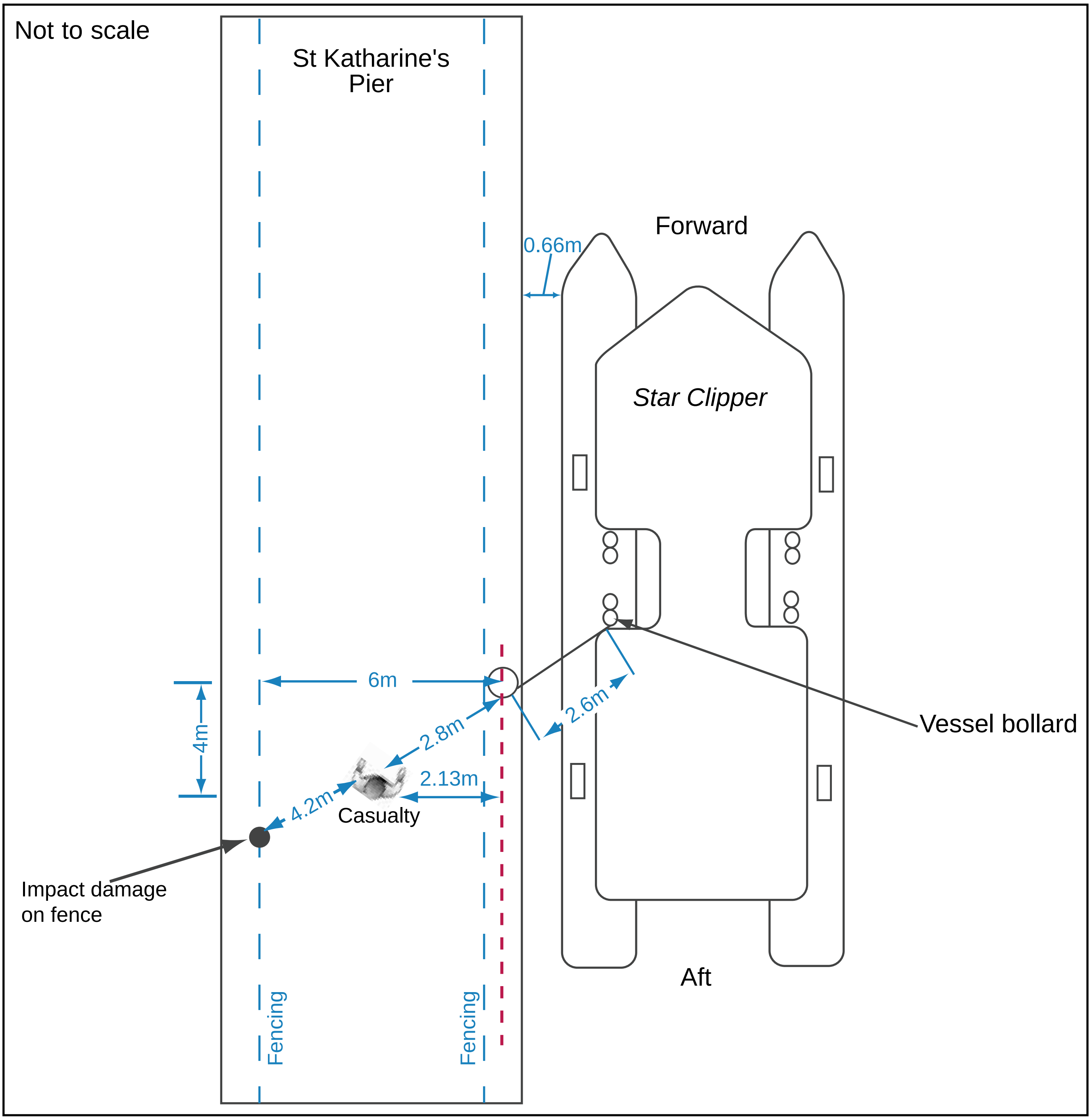
The Test House (Cambridge) conducted comparison tests on paint samples from the bollard, insert plate and from the accident site in an attempt to ascertain the bollard trajectory. The results were inconclusive.

1.18 RE-ENACTMENT

A re-enactment of the events leading up to the accident was conducted at St Katharine's pier on 3 June 2004, using the same crew that were onboard on 2 May. The environmental conditions were very similar to those on 2 May 2004.

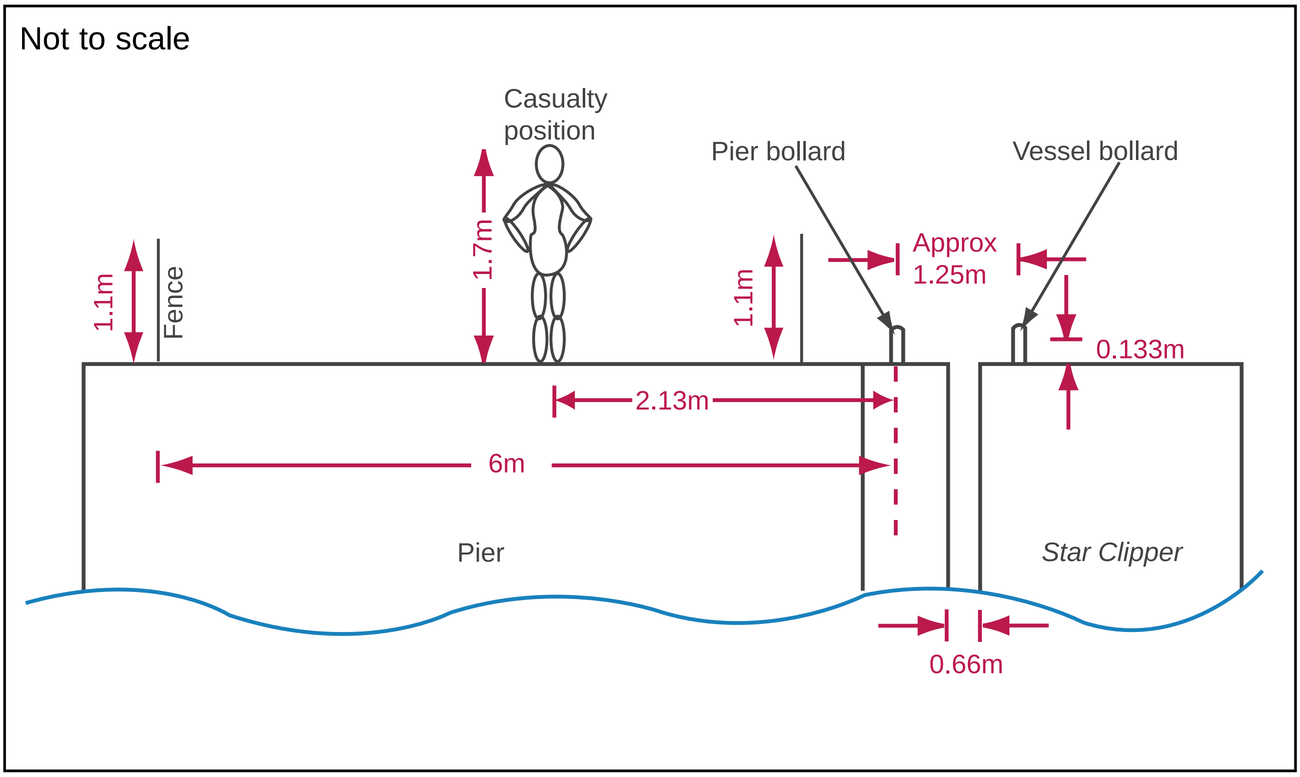
As a result of the re-enactment, it was possible to accurately ascertain the position of the casualty relative to the pier and vessel's bollards **(Figures 21** and **22)**.

Figure 21



Casualty's position immediately prior to accident

Figure 22



Casualty's position immediately prior to accident

1.19 OPERATING COMPANY SAFETY ORGANISATION

Before the accident, CRE had made a conscious effort to improve its safety culture and associated management structure. A dedicated safety manager was recruited in September 2003, and a comprehensive range of vessel operating procedures and associated risk assessments, and a safety management code, were produced.

Training and competency assessment procedures were put in place. Training exercises and programmes were fully recorded.

1.20 RIVER THAMES'S PIERS - PASSENGER SAFETY ARRANGEMENTS

Responsibility for providing passenger safety on the River Thames's piers falls to the individual pier owners. Each owner has a responsibility to safeguard passengers in accordance with the employer's duties as defined by Section 3 of the HSAW Act. It is expected that a risk assessment be conducted and control measures put in place to reduce risks, including those to passengers.

The facilities at St Katharine's Pier are regularly maintained and are in good working order. The previous owners of the pier had conducted a risk assessment covering the pier structure and its use.

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 BOLLARD REPLACEMENT

The original bollards required the crew to access the narrow walkway adjacent to the passenger cabin. There are no guardrails in this area, and no room to fit them without impeding access. Using these bollards routinely could be extremely dangerous, especially during poor weather or during icy conditions. Merchant Shipping Notice No M718, issued in 1975, advises shipbuilders to ensure that mooring arrangements are fit for the purpose of the intended vessel operation. Siting the additional two mooring bollards in the passenger access areas provided the crew with a greater degree of safety than using the original fit bollards.

There had been a number of previous unreported bollard failures, but reasons for the failures had not been identified. It was reasonable for CRE to assume that the **Mk I** bollards, fitted by Serco Denholm, were installed to an approved standard. However, CRE's response of increasing the size of bollard materials to overcome the problems they subsequently experienced, was inappropriate, and they should have sought expert advice.

2.3 REPORTING OF DEFECTS

The requirement for the owner to report defects affecting safety or efficiency of the vessel is laid down in statute (Paragraph 1.12). The conditions for the issue of the Passenger Certificate also reinforce the requirement to report defects **(Annex B)**. The failure of the passenger platform structure on 9 April 2004 had a possible impact on the structural integrity of the hull. The validity of the Passenger Certificate could therefore have been in doubt. However, the owner decided not to report the fault to the Certifying Authority. In his view, the subsequent modification utilising increased plate dimensions was sound, and fit for purpose and ship's safety was not compromised.

Owners are sometimes unclear about how to report defects, and are reluctant to report those which, in their opinion, will not necessarily jeopardise a vessel's safety. Guidance to owners needs to be reinforced, to ensure there is no ambiguity when reporting defects.

2.4 MCA INSPECTION AND SURVEY

The onus to report defects, and structural and equipment changes, rests with the owner, but the MCA also has the opportunity to identify areas of concern during periodic surveys and inspections.

The MCA's "Instructions for the Guidance of Surveyors, Passenger Ship Construction Classes III – VI (A) is clear. **Annex E** paragraph 13.1.1 requires that surveyors are satisfied that principal structure scantlings are maintained. Although the instruction does not explicitly mention bollard arrangements, they do advise that ***"****the ship is, in all respects, fit for the service intended".* An opportunity was therefore lost for timely identification of the emerging defects following survey.

This investigation found that the bollard arrangement was not properly attached to the ship's structure to ensure a firm foundation for the dissipation of the bollard's load. Because the bollard was not properly supported, unacceptable load was imposed on the passenger platform, which was itself attached to the hull structure via the hull cross beams.

There was evidence of a damaged **Mk I** bollard onboard at the time of the survey in February 2004. The survey could have prompted an inspection of the bollard and its supporting structure. If this had been done, the inspection could have revealed the inadequacy of the arrangement for the service intended.

2.5 SUITABILITY OF THE BOLLARD SUPPORTING STRUCTURE

The failure of the 3mm aluminium passenger access platform deck on 9 April resulted in the mooring bollard being partially torn from the deck.

The weak point in the mooring arrangement should have been the mooring rope, which should have parted prior to the structure giving way. As this was not the case, there was an opportunity for CRE to examine the cause of failure in more detail. They could have sought professional advice on whether the bollard supporting arrangements were sufficient for the likely mooring loads.

2.6 WELD REPAIR FAILURE AND INSERT PLATE MATERIAL SELECTION

Correct material selection and repair procedures are a fundamental part of ensuring a vessel meets the stringent certification requirements. Only by defining these is it possible to confidently ensure that passenger and crew safety is not compromised.

There was no agreed repair specification and only superficial repair quality assurance measures were taken following the bollard failure on 9 April. These were cursory visual examinations of the finished weld and bollard plate fastenings by inexperienced CRE employees. They were inadequate for this safety critical load bearing arrangement.

2.6.1 Material selection

Insufficient consideration was given by both CRE and Alweld to the importance of correct material selection for the bollard insert plate. No professional advice was sought. The only consideration given was that the plate was large enough to cover the damaged deck area and accommodate the bollard, and that it was substantially thicker than the original material. The aluminium used for the insert was an “off cut”. No thought was given as to whether it would be suitable for the likely operational requirements.

2.6.2 Weld repair considerations

The initial damage to the checker plate, and stretching of the securing bolt holes, was an opportunity to alert the welder/fabricator to the lack of structural strength in the passenger access area. He did not raise any concerns with CRE, perhaps because of his lack of experience.

CRE, recognising that they did not have the experience to advise on the technical details of the repair, left the engineering decisions to the young welder. The only stated requirement was that the insert plate was to be of thicker material. Merchant Shipping Notice M718 **(Annex F)** emphasises the need to ensure that weld repairs to mooring, towing and hauling equipment are carried out by a fully competent welder. Based on the results of previous Alweld welding and fabrication work on Thames Clipper vessels, CRE believed that Alweld were competent, and therefore satisfied the requirements of M718.

The welder did seek advice and approval from his father, who was in France on holiday at the time. However, approving the repair process, without having seen the failed item and the scope of work, could have easily led to a misunderstanding regarding the complexity of the repair.

2.6.3 Shear forces required for failure

The independent report on the bollard failure indicated that if all of the insert plate weld failed simultaneously, the shear force required to achieve this would be in the region of 321.9kN. This is far in excess of the rope’s actual breaking force of 65.04kN. Therefore, if this was the mode of failure, the rope would have parted before the bollard failed. This was not the case, therefore, the forces required for the weld to fail must have been below 65.04kN.

Visual examination of the deformation of the insert plate, indicate failure through progressive tearing. This appears to have initiated at the inboard edge and propagated around the weld, bending the corners as it did so, before being catapulted into the waiting passengers. The independent report suggests that a relatively low shear force of 47.1kN, equating to a vessel speed of between 0.3 and 1.3 knots, is required to achieve this, a force well within the rope’s breaking force.

What is less clear is whether the initial propagation occurred at the time of mooring at St Katharine's Pier on 2 May 2004. While the mate did not notice any defects with the repair arrangements, it is probable that initial propagation occurred some time between the completion of the repair on 12 April and 2 May. During this period, there were approximately 1200 moorings. Each might have contributed to the insert plate deformation.

2.7 VESSEL OPERATION

2.7.1 Approach to St Katharine's Pier

CRE does not have any specific instructions for its captains, on procedures for coming alongside piers. Owing to the constantly changing conditions on the river, it would be unreasonable to provide such instructions, other than on how to moor the vessel. *Star Clipper*'s captain was an experienced, fully licensed Waterman. He had undergone a period of training and assessment for his suitability for the role and could competently assess the appropriate approach procedure to suit the circumstances. There is no concern regarding his vessel handling ability, or that of his crew.

The captain's final procedure for coming alongside St Katharine's Pier, on 2 May 2004, was consistent with that expected by the company's fleet operations manager, who conducts the competency assessments.

However, before berthing *Star Clipper* at St Katharine's Pier he did overtake *Sarpedon*, which was exiting the northern bankside arch of Tower Bridge. *Sarpedon* was making 3 - 4 knots onto the pier, which is only 100m from Tower Bridge. Clearly, *Star Clipper* must have been making in excess of 4 knots to enable her to reach the berth before *Sarpedon*.

Some witnesses, including the casualty's husband, have commented that the vessel approached the pier at speed. A number have also said that the approach was normal and safe, including the captain of *Sarpedon,* an experienced licensed Waterman, who was immediately astern of *Star Clipper*. None of these statements can be verified by supporting evidence such as CCTV footage. However, the vessel is extremely manoeuvrable and was perfectly capable of approaching the pier at a safe speed after overtaking *Sarpedon.*

2.7.2 Coming alongside

The process of mooring a vessel has the potential to impose large stresses on her mooring equipment. It is important that the captain's intentions are unambiguous and understood by the crew so that potentially dangerous situations are prevented from developing.

Star Clipper's captain was conscious that *Sarpedon* also wished to come alongside the pier. He decided that it would be helpful to move towards the eastern end of the pier, astern of *Sarah Kathleen*, rather than go to the usual position on the pier. Unfortunately, he did not inform the mate of his intentions prior to coming alongside. As far as the mate was concerned, the vessel was going to her normal mid-gate position. The passengers heard the captain say "we will go to the next gate", by which time the mate had already passed a rope ashore and put a running turn around the vessel's bollard. There is no evidence to suggest that anything other than minimal power was applied to move the vessel ahead.

The mate reported that, at the time of the bollard failure, *Star Clipper* was slightly less than 1m from the pier, and that the captain was using minimal ahead way to bring *Star Clipper* alongside. He, and the waiting passengers, noticed that the pier was "bouncing" from the wash effect from a number of small vessels in the vicinity. This surface disturbance would have added to the stresses on the mooring bollard.

When the insert plate weld failed, *Star Clipper* did not surge up the pier, so the propulsion thrust at this point must have been minimal. Witnesses, who were standing in the passenger cabin at the time, stated they felt no sudden movement, and none was noticed by those passengers standing on the pier. This further supports the view that the applied power was minimal.

2.7.3 Mooring procedures

The routine of using the eye of the mooring rope to capture the pier bollard, and then securing the loose end to the vessel's bollard, prevents the need for the mate to jump ashore, thus avoiding the risk of injury. Securing the mooring rope ("fetching up") prior to the vessel coming alongside, enables the captain to use the rope as a "spring". This speeds up the mooring process, but in turn puts considerable stress onto the bollards and rope. The stress is exacerbated by the pier's "bouncing" motion, which also "snatches" at the rope.

Stresses imposed on the mooring bollards could be reduced if, once the eye of the rope has been passed onto the shore bollard, a running turn is made around the ship's bollard instead of "fetching up" the rope. This would allow the amount of weight coming onto the rope and bollard to be controlled by slacking the rope down as required. Once the rope has been passed around the vessel's bollard, the captain could manoeuvre into position alongside the pier, using the rudder and water jets controls. Once the vessel is in position the mooring rope could then be made fast.

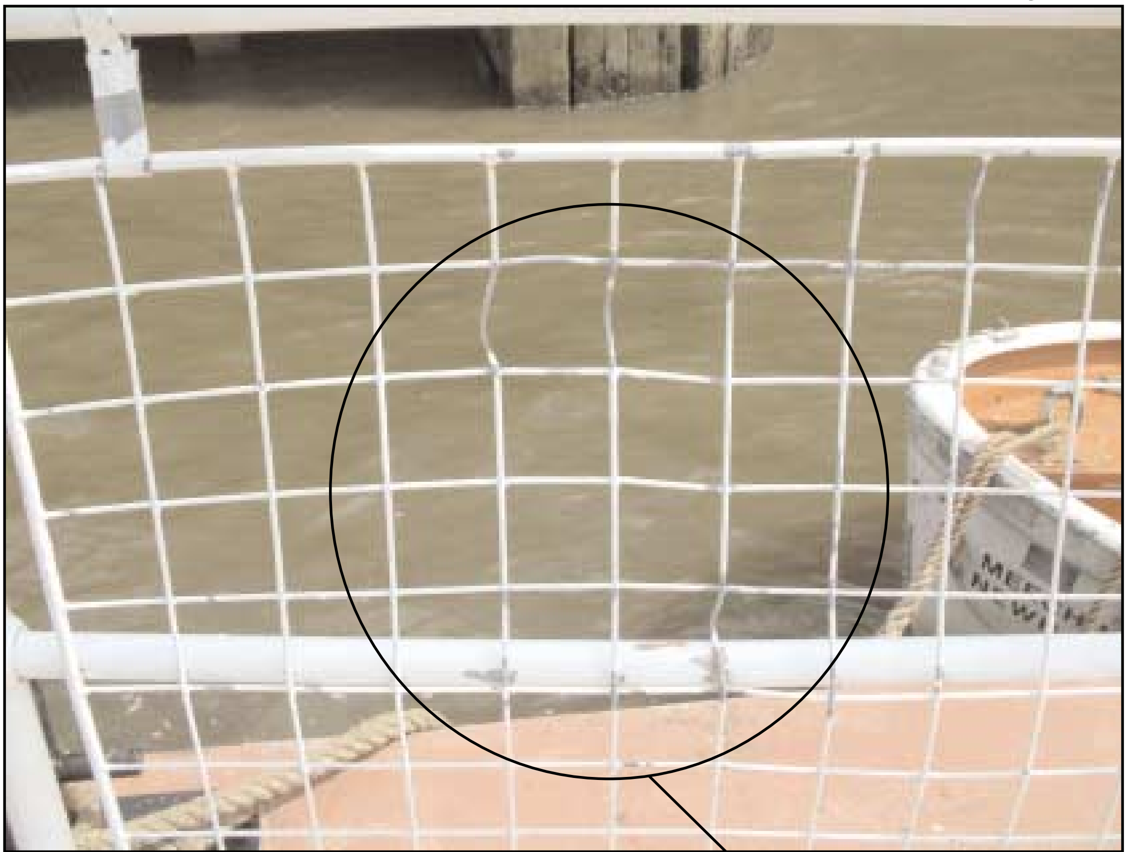
2.8 BOLLARD TRAJECTORY

To better understand how much stored energy was required in the mooring rope for it to rip the bollard from the vessel and catapult it across the pier, it was necessary to determine how the bollard managed to jump the riverside safety fence. None of the crew, onboard passengers, or those waiting on the pier saw the path taken by the bollard after failure.

From the results of the re-enactment, it was possible to ascertain the path taken by the bollard by establishing the relative positions of the vessel, bollard, pier bollard, casualty position and impact damage on the bankside safety fencing.

The results of the independent study suggest the most likely scenario was that the vessel bollard hit the pier bollard and was deflected over the riverside safety fencing. It hit the lady and then the bankside safety fence **(Figure 23)**, before landing on the pier.

Figure 23



Damage to bankside safety fencing

2.9 ROPE SELECTION

When the safety manager joined CRE in September 2003, he recommended that the company use nylon ropes, instead of polypropylene ropes, because of the nylon ropes' ability to absorb greater shock loads. Hence their suitability to cope with "snatching" and wash-related stresses during mooring. This recommendation was not made on the basis that he was aware of bollard failures, but was based on his previous marine experience.

Following this initiative, mooring trials were conducted using nylon ropes during normal commuter services. It was reported that the crews disliked using them, mainly because of the greater stretch properties and weight of nylon compared with polypropylene. Polypropylene ropes are also easier to splice than nylon ropes, and they tend to be stiffer, and are therefore easier to handle and throw over the bollards.

On some occasions when nylon ropes were used it was found that when they stretched, the vessel moved up the pier away from the open passenger gates, thus impeding the access by passengers, and risking their safety. In common with the majority of River Thames users, CRE has reverted to using polypropylene ropes.

2.10 PIER SAFETY

The facilities at St Katharine's Pier are well maintained and the pier is considered fit for purpose.

There is no suggestion that the pier arrangements contributed in any way to the accident. However, St Katharine's Dock harbourmaster, stated that the risk assessment associated with pier operations was in need of updating, having been completed during the previous owner's tenure.

It is important for owners of River Thames piers to keep their operations under review to reflect changing requirements and to ensure pier safety.

2.11 FATIGUE

The crew of *Star Clipper* were all well rested prior to assuming their duties between 0900 and 1000 on 2 May 2004. They had completed only one round trip before the accident. Fatigue is not considered a factor in this accident.

2.12 PLA AND RNLI REACTIONS

Both the crews of the PLA harbour launch *Westbourne* and Tower lifeboat responded extremely quickly to the request for assistance. Both teams were faced with the very difficult situation of a casualty in deep trauma and a number of waiting passengers suffering from shock. They conducted themselves in a calm and thoroughly professional manner throughout the accident.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES

The following safety issues have been identified by the investigation. They are not listed in any order of priority:

1. The passenger access platform structure was inadequate to support the bollard stresses imposed during normal mooring operations. [2.3, 2.5]

2. The original build, forward bollards are unsuitable for routine commuter service mooring requirements. The access to the bollards is hazardous and there are no guardrails. [2.2]

3. The cause of earlier bollard failures was not sufficiently investigated to check suitability of the structure or of the impact of mooring operations. [2.2]

4. CRE did not inform MCA of the replacement of the bollards or the subsequent failure on 9 April 2004. [2.3]

5. There were no weld specification or adequate quality assurance measures in place for the bollard repair following the failure on 9 April 2004. [2.6]

6. During the MCA inspection and survey on 2 and 18 February 2004, no bollard defects were recorded. [2.4]

7. MCA's Guidance of Surveyors does not explicitly cover mooring arrangements. [2.4]

8. Insufficient consideration was given to the importance of correct material selection for the bollard insert plate. [2.6.1]

9. The weld repair and 6mm aluminium insert/doubler lacked the necessary strength to ensure that the bollard could accept normal mooring loads. [2.6.3]

10. The mooring rope was secured to both the pier and vessel before it was alongside, causing stresses to be built up in the rope and bollard structure. [2.7.3]

SECTION 4 - ACTION TAKEN

4.1 MARITIME AND COASTGUARD AGENCY

The MCA published a "Safety Alert" Marine Information Note, MIN176 (M+F), in May 2004, titled "Mooring Cleat Failures". The publication highlighted the need to regularly examine mooring equipment fastenings, and provide advice on berthing aimed at reducing loading on mooring equipment. A copy of the Safety Alert is at **Annex G**.

On 10 May 2004, the MCA (South East District) required owners and operators of all Class V vessels operating on the River Thames to check all bollards and deck connections. Positive reporting was required within 7 days of the instruction. A copy of the instruction is at **Annex H**.

4.2 PORT OF LONDON AUTHORITY

The PLA issued an instruction on 13 May 2004 to the owners and operators of all PLA licensed passenger vessels (carrying 12 passengers and under) to check the integrity of mooring arrangements. A copy of the instruction is at **Annex I**.

This instruction has been amended to include inspection of mooring equipment and associated fittings on all types of commercial vessels on the PLA shipping register.

4.3 COLLINS RIVER ENTERPRISES

On 3 May 2004, CRE conducted a risk assessment and issued an operating procedure to cover "Mooring arrangements for the embarkation and disembarkation of passengers". A copy of the risk assessment and operating procedure is at **Annex J**.

CRE has conducted evaluation of the mooring rope loadings, to determine the bollard supporting structure design. The design has been approved by the MCA.

4.4 ST KATHARINE'S DOCK HARBOURMASTER

The St Katharine's Dock harbourmaster has reviewed and updated the risk assessment relating to the operation of St Katharine's Pier.

SECTION 5 - RECOMMENDATIONS

The Maritime and Coastguard Agency is recommended to:

2005/112 Review the Guidance of Surveyors, Passenger Ship Construction Classes III – VI (A) and associated surveyor's aides memoire to include the requirement to conduct an external visual inspection of any bollards and mooring equipment that are fitted.

2005/113 Revise and re-issue the instructions under MSN No M.718 covering the importance of the need for careful weld preparation, correct material selection and the use of fully qualified and competent welders when undertaking repairs to mooring, towing and hauling equipment.

2005/114 Promulgate additional guidance to owners on the requirement to report details of proposed mooring fitting modifications, general defects and changes in a vessel's use to the Certifying Authority for approval in accordance with statutory requirements and conditions attached to the Passenger Certificate and Domestic Safety Management Certificate.

Collins River Enterprises are recommended to:

2005/115 Take into account, where appropriate, the need to seek expert advice on technical matters. In particular, where structural repairs or modifications are proposed to ensure that materials are correctly selected, and repairs follow approved procedures and standards to cope with expected "in service" loads.

Marine Accident Investigation Branch
February 2005