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ENVIRONMENT
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MAIB

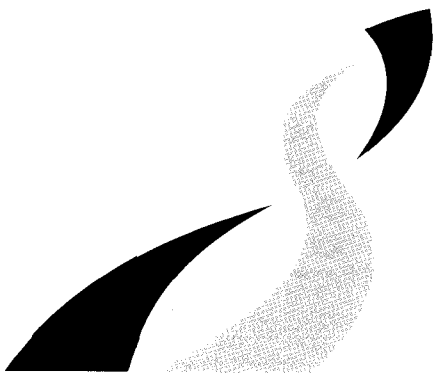
MARINE ACCIDENT INVESTIGATION BRANCH

Marine Accident Report 2/99

Report of the Inspector's Inquiry
into the collision of

mv *SAND KITE*

with the
THAMES FLOOD BARRIER
on 27 October 1997



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INVESTOR IN PEOPLE

April 1999

Marine Accident Investigation Branch
of the Department of the Environment
Transport and the Regions: London

Marine Accident Investigation Branch
Department of the Environment, Transport and the Regions
Carlton House
Carlton Place
Southampton SO15 2DZ

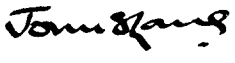
8 March, 1999

The Right Honourable John Prescott MP
Deputy Prime Minister and Secretary of State
for the Environment, Transport and the Regions

Sir

I have the honour to submit the Marine Accident Investigation Branch report on the collision of mv *Sand Kite* with the Thames Flood Barrier on 27 October 1997.

I have the honour to be
Sir
Your obedient servant



J S Lang
Rear Admiral
Chief Inspector of Marine Accidents

Extract from
The Merchant Shipping
(Accident Reporting and Investigation)
Regulations 1994

The fundamental purpose of investigating an accident under these Regulations is to determine its circumstances and the causes 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.

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Glossary of abbreviations and acronyms

DGPS	differential global positioning system
EA	Environment Agency
EBL	electronic bearing line (on radar)
GPS	global positioning system
ISM Code	International Safety Management Code
MAIB	Marine Accident Investigation Branch
"Mayday"	Signal of Distress (over radio)
PCL	Port Control London
PEC	Pilotage Exemption Certificate
PLA	Port of London Authority
TBCC	Thames Barrier Control Centre
TBNC	Thames Barrier Navigation Centre
UTC	Universal Co-ordinated Time
VDU	visual display unit
VHF	very high frequency (radio)
VRM	variable range marker
VTS	Vessel Traffic Services

Synopsis

The accident was notified to the Marine Accident Investigation Branch (MAIB) by South Coast Shipping Co Ltd at 0900 on 27 October 1997 and an investigation commenced the same day. It was carried out by Captain Nick Beer.

During the early morning of 27 October 1997, mv *Sand Kite*, a 98m long trailing suction dredger was inbound in the River Thames and making for a berth about half a mile upriver of the Thames Flood Barrier. She was loaded with approximately 3,300 tonne of sand and gravel. While trying to navigate through one of the barrier's spans in thick fog at 0648, she collided with one of its concrete piers. Although she was holed and started to take water immediately, she was moved astern and clear of the designated navigable span before coming ahead in an attempt to pass through an adjacent span. As she did so her bow sank and came to rest on the river bed on top of the housed barrier gate. The gate was effectively put out of commission until such time as the vessel was successfully refloated and the majority of her lost cargo removed.

At the time of the accident, the barrier's navigation and fog lights were switched on and functioning correctly. *Sand Kite* was equipped, manned and certificated in accordance with international, national and local regulations.

The investigation has concluded that the accident occurred as a result of a navigational error by the master. This was partly caused, and compounded by, poor bridge team management. The investigation also concluded that the Port of London Authority (PLA), through its officers at the Thames Barrier Navigation Centre (TBNC), did not exert sufficient control over the river traffic in the hour before the accident.

On 16 January 1998 MAIB made interim recommendations to the PLA concerning the operation of its Pilotage Exemption Certificate (PEC) system. This report makes further recommendations to the PLA concerning the operation of the TBNC, and to the owner of *Sand Kite* concerning bridge management and training on its vessels.

Figure 1: Sand Kite [photograph courtesy of South Coast Shipping]

Vessel and Incident Particulars

Name	:	*Sand Kite* (ex *Bowknight* –1993)
Type	:	Dredger/Sand Carrier
Official No	:	361446
Port of registry	:	Cardiff
Year of build	:	1974
Registered length	:	98.68m
Maximum draught	:	5.941m
Gross tonnage	:	3,110
Place of build	:	Troon
Propulsion	:	Two Rushton diesel engines driving a single controllable pitch propeller
Thruster	:	Athwartships Tunnel Thruster forward
Service speed	:	13.5 knots
Owner	:	East Coast Aggregates Ltd
Operator	:	South Coast Shipping Co Ltd
Crew	:	Master, two mates, chief engineer, second engineer, two third engineers, two engineer cadets, bosun, two able seamen and a cook
Accident	:	Collision with Thames Flood Barrier
Date of accident	:	27 October 1997
Time of accident	:	0648 UTC
Place	:	Woolwich – Thames Flood Barrier
Damage	:	Extensive damage to vessel and superficial damage to barrier
Injuries	:	None
Pollution	:	None

SECTION 1
Factual information

(All times are UTC)

1.1 BACKGROUND TO THE VOYAGE

Sand Kite is one of eight vessels operated by South Coast Shipping Co Ltd. They are employed to dredge aggregates from various licensed coastal exploitation sites for delivery to one of a number of North Sea and Channel ports. Angerstein's Wharf, on the south bank of the Thames, about a half mile above the Thames Flood Barrier, is an unloading berth often used by *Sand Kite*. A typical round voyage, depending on tidal cycles, from berth to berth, takes approximately 24–36 hours. It involves making the outbound passage to the dredging area, loading, the return passage and discharging.

The Thames Flood Barrier, which became operational in 1982, spans the River Thames in Woolwich Reach. The barrier exists to protect London from the serious risk of catastrophic flooding due to tidal surges and had been operated 30 times for this purpose. It is operated and maintained by Environment Agency (EA) staff.

The regulation of navigation in the vicinity of the barrier is the responsibility of the Port of London Authority. The PLA's Thames Barrier Navigation Centre, which overlooks the barrier, is manned continuously by a roster of teams each comprising two personnel: a duty marine officer, who is a master mariner, and a Vessel Traffic Services (VTS) operator. Their function is to monitor and regulate the river traffic as it approaches, and passes through, the barrier. The duty marine officer has the full delegated authority of the harbour master in carrying out this responsibility (**Figure 2**).

1.2 NARRATIVE OF EVENTS – VESSEL AND TBNC

After discharging a cargo of sand and gravel at Angerstein's Wharf, *Sand Kite* sailed at 0836 on Sunday 26 October 1997 and made the 115 mile passage to the Hastings Bank dredging area, off the Sussex coast, where she arrived at 1736. She began to load straight away.

The watch change at TBNC occurred at 1900 with the new duty marine officer and VTS operator starting their 12 hour watch at this time.

Sand Kite completed loading at Hastings Bank at 2036. The dredge gear was stowed and the vessel departed the area bound for Angerstein's Wharf at 2047 with an estimated 3,300 tonne of sand and gravel on board. The senior mate was on watch in the wheelhouse assisted by an able seaman whose role at that time was to act as bridge lookout. *Sand Kite* rounded Dungeness at about 2220 and passed Dover just before midnight.

At 2300 in the TBNC the VTS operator went below to rest leaving the duty marine officer manning the operations room.

Figure 2: The Thames Barrier [photograph courtesy of Chorley & Handford Limited]

At midnight, the bridge watch on *Sand Kite* was handed over to the junior mate. At 0112 on 27 October, just before the vessel entered the seaward limit of the Port of London, the junior mate registered his Pilotage Exemption Certificate (PEC) with Port Control London (PCL). The visibility was good (**Figure 3**).

At 0215 the VTS operator returned to the operations room at TBNC. The duty marine officer went below to rest at 0230, leaving instructions to be called if visibility reduced.

When *Sand Kite's* able seamen changed watches at 0400, the vessel was proceeding westward in Sea Reach channel at the entrance to the River Thames. At about this time the officer of the watch, the junior mate, heard a report of fog in the vicinity of the Muckings and posted the able seaman, who had just started his watch, as lookout on the bridge.

At the same time the VTS operator at TBNC called the duty marine officer to warn him that visibility had reduced. As there was little or no traffic, the duty marine officer asked to be kept informed and stayed below in the rest room. The barrier's high intensity fog lights were turned on at 0415. At that time Foxtrot Span was designated for inbound traffic.

The master of *Sand Kite* was called at 0440 as the vessel was passing Sea Reach 7 buoy. This was a little earlier than usual but, as the master wished to be informed in the event of reduced visibility, he was called because a fog bank had been detected ahead. He arrived in the wheelhouse at about 0500 as the vessel approached Thames Haven. The junior mate had, meanwhile, reduced speed to 10 knots to pass "The Havens". The visibility was very poor and estimated to be about 0.3 miles.

The routine for navigating in poor visibility was discussed between master and mate and agreement reached that the master would monitor the vessel's track principally using information derived from the starboard radar. His intention was to give appropriate course orders and steering instructions to the mate who would steer using the autopilot. Because visibility was so poor, the able seaman lookout remained on the bridge with instructions to report the sighting of buoys and other lights as they became visible during the vessel's passage through Lower Hope Reach and her turn into Gravesend Reach.

On passing the Ovens buoy at the eastern end of Gravesend Reach at 0515, *Sand Kite* reported to PCL. She was one of several vessels inbound on the flood tide and the master adjusted his speed to remain about half a mile astern of *Thames*, an effluent carrier bound for Becton and of similar size to *Sand Kite*.

Indications of visibility at various locations were received by *Sand Kite* as other vessels reported the conditions to PCL or TBNC. As *Sand Kite* approached the western end of Gravesend Reach at about 0530, the visibility improved to between 0.5 and 0.6 miles. The opportunity was taken to send the lookout below to measure the cargo and prepare for mooring stations.

The mates changed watches at about 0600 when the junior mate was relieved by the senior mate. The routine for navigation remained as agreed earlier, with the mate steering using the autopilot while the master conducted blind pilotage using the starboard radar. The junior mate remained on the bridge to give the master a short break and went below at 0615 as the vessel entered Halfway Reach. The visibility had again reduced because of dense fog.

Sand Kite passed Crayford Ness at 0606 and notified both PCL and TBNC. On passing Crayford Ness she entered the area monitored by the TBNC (**Annex**). Shortly afterwards the vessel immediately ahead, *Thames*, was heard arranging to overtake *James Prior*, a small inbound sand carrier.

Sand Kite overtook *James Prior* just before Coldharbour Point. To achieve this the master increased speed to about 11 knots over the ground (the speed of *Thames*) from whom he maintained his distance.

At 0609, *Brenda Prior*, another small sand carrier which was the first of the inbound vessels that morning, called TBNC to ask permission to use Echo Span instead of the designated Foxtrot. The TBNC VTS operator gave permission for Echo Span to be used and turned on the appropriate high intensity fog lights. *Brenda Prior* subsequently called TBNC at 0613 to report she had just picked up the fog lights at a range of 0.2 miles.

On board *Sand Kite*, meanwhile, the able seaman watchman visited the bridge and reported the results of his cargo measurement. He was instructed to call the bosun and then to stand-by until required for mooring stations. The time was 0615. Soon afterwards the junior mate went below to his cabin.

At 0615 TBNC made its regular twice-hourly navigation broadcast (**Annex**). The broadcast included the warning of fog in all reaches. At about this time the TBNC duty marine officer returned to the operations room.

Arco Beck, another aggregates dredger, reported to TBNC she was entering the barrier control zone and passing Margaret Ness at 0618. She was told to use Echo Span.

As *Thames* needed to swing off Becton, her master called *Sand Kite* to ask whether she would like to pass. *Thames* co-operated by reducing speed to enable *Sand Kite* to overtake off Ford's at Dagenham. This placed *Sand Kite* astern of another aggregates dredger, *City of Westminster*, also inbound and now about 0.5 miles ahead. Visibility had improved to about half a mile again but was described as "up and down all the time".

At 0620, *City of Westminster*, which was due to berth immediately downstream of *Sand Kite*, called to offer *Sand Kite* the opportunity to overtake to prevent subsequent mutual interference when off their respective berths. *Sand Kite*'s master agreed and said he would keep close up to her stern to enable him to pass quickly and not delay *City of Westminster* unduly.

Both *City of Westminster* (at 0630) and *Sand Kite* (at 0632) reported into TBNC at Margaret Ness that they were entering the barrier control zone (**Annex**). They were both told to use the barrier's Echo Span. *City of Westminster* slowed to allow *Sand Kite* to pass.

Sand Kite went into hand steering with the senior mate on the wheel. Her speed was temporarily increased to about 13 knots over the ground as she passed to the south of *City of Westminster* in Gallions Reach. As she did so *City of Westminster*'s deck lights could just be seen from *Sand Kite*.

Arco Beck reported she was clear of the barrier at 0639. *City of Westminster* contacted her to enquire about visibility at the barrier and was informed by *Arco Beck* that the fog lights had been seen initially at a range of 0.2 miles.

As *Sand Kite* rounded Bull's Point her position was a little to the south of the centre of the river having overtaken *City of Westminster*. On entering Woolwich Reach, her master reduced speed to about half ahead and then progressively reduced further with the intention of coming down to minimum steerage way before reaching the barrier. The bow thruster was switched on in anticipation of swinging in the river off the berth on the upriver side of the barrier.

As she passed between the Woolwich Ferry terminals, both good radar targets, *Sand Kite* was in the centre of the channel. It was the master's intention to bring the vessel up to the "top third" of the river by the time she was off the refinery berths at North Woolwich and about 0.35 miles before the barrier, and then steer 265° through the barrier's Echo Span. He told the senior mate, who was still using hand steering, of his intentions. When *Sand Kite* was between the ferry terminals, the master set the radar's electronic bearing line (EBL) on the eastern end of the radar target that indicated the refinery jetty ahead. He read the bearing as 285° and ordered the mate to steer this (**Figure 4**).

While steering 285° the master set the EBL on 265° with the intention of waiting until it had nearly intercepted the radar target of Pier 6 at the southern side of Echo Span before ordering a change of course to port to 265°.

At 0644, *Sand Kite* had half a mile to run before passing through the barrier. The master called Woolwich Radio to ask for the high intensity fog lights to be switched on. He was informed they were already on. They were not visible from the bridge of *Sand Kite*.

When the EBL was just touching the target of Pier 6 and the vessel was off the refinery jetty on a heading of 285°, the master ordered the mate to "come slowly to port". The speed of the vessel was about 6–7 knots over the ground at this time (**Figure 5**).

The master continued to navigate using the radar and was watching the EBL's position relative to the piers of Echo Span. He also watched the vessel's heading marker converge with the EBL as *Sand Kite* turned. At the same time he was hoping the barrier's fog lights would become visible to allow him to navigate through the barrier by eye. While waiting for this to happen he became aware the vessel was not turning quickly enough.

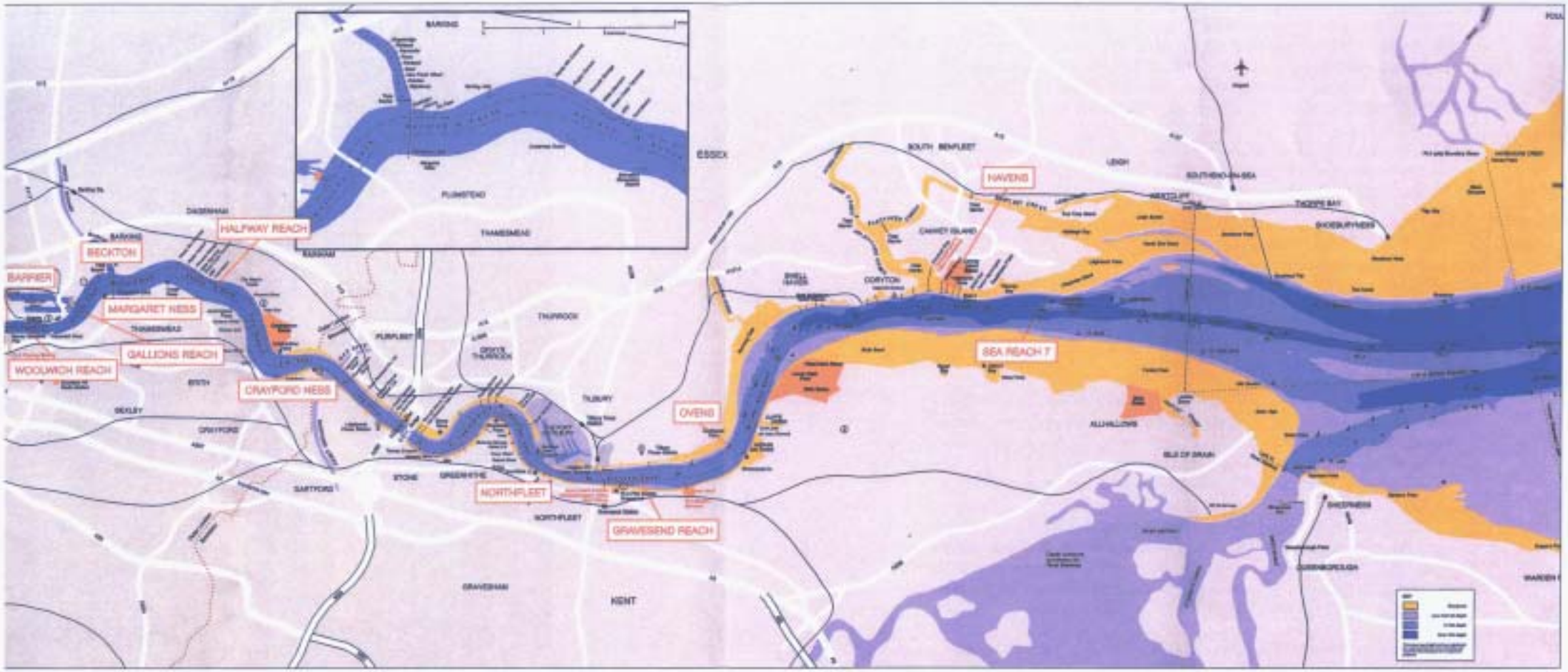
At 0.2 miles the barrier lights became visible. The two fog lights marking Piers 5 and 6 appeared on the port bow with the left, or southerly, one showing more dimly than the other which indicated that the vessel was to the north of the required span. There is conflicting evidence as to whether *Sand Kite* had steadied on 265° by this time; there is no disputing her speed was still in excess of 6 knots over the ground.

Meanwhile the TBNC VTS operator had noticed that *Sand Kite* was to the north of the normal approach track and indicated this to the duty marine officer who called *Sand Kite* on VHF at 0647 to ask whether she could see the barrier's lights. The master replied that he could see the span.

Realising he was offset to the north and closing the barrier, the master put the engine power to full ahead to increase the rate of turn and then relieved the senior mate at the wheel. He immediately put the wheel hard to port but, although the vessel started to swing, it was too late to avoid contact with Pier 5. Just prior to the impact he ordered the mate to put the engines full astern and the bow thruster to port.

The starboard bow of *Sand Kite* made heavy contact with the end of the pier causing

The Thames Estuary



on – the River Thames from Teddington to the Tongue [Reproduced by courtesy of the Port of London Authority]

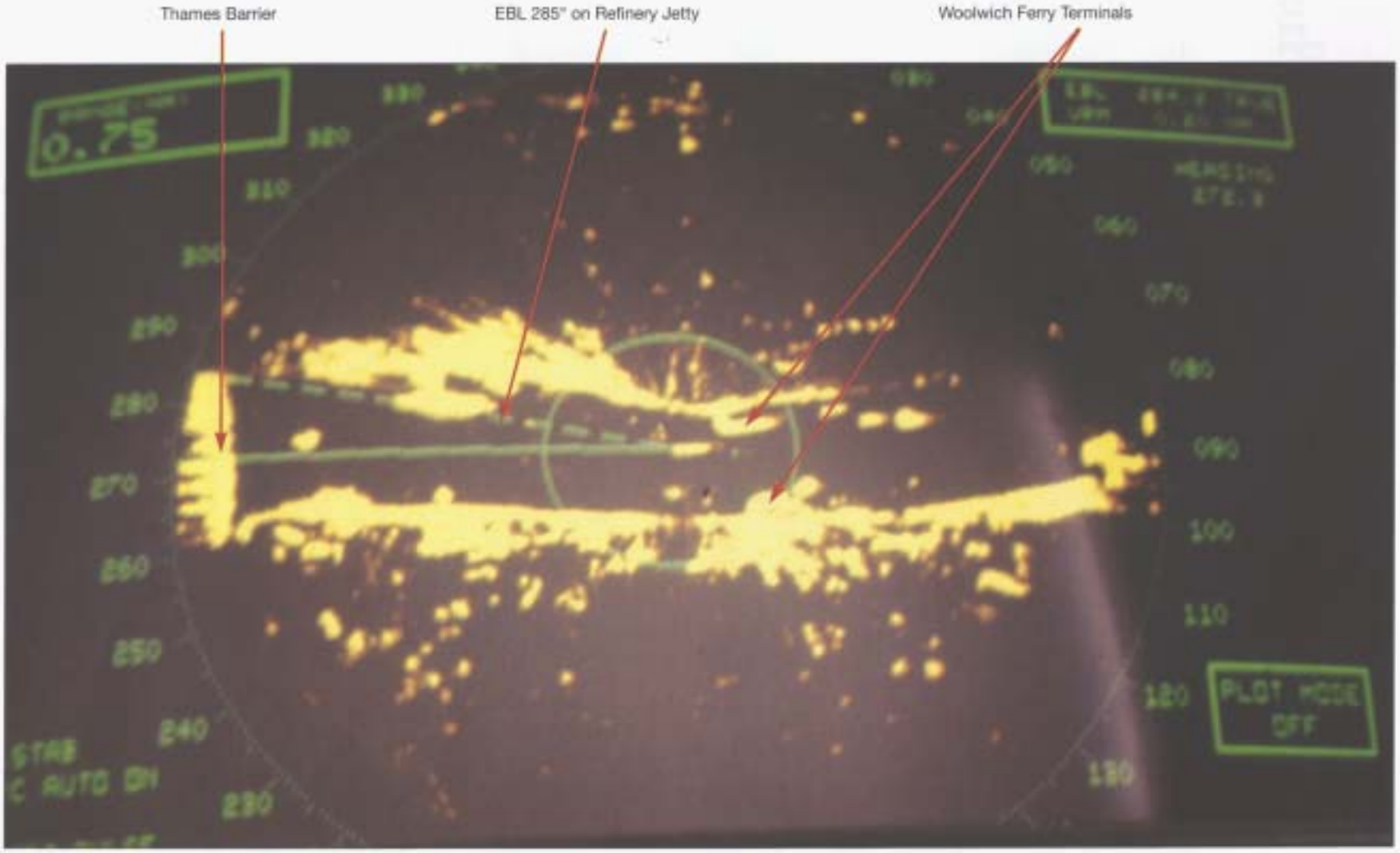
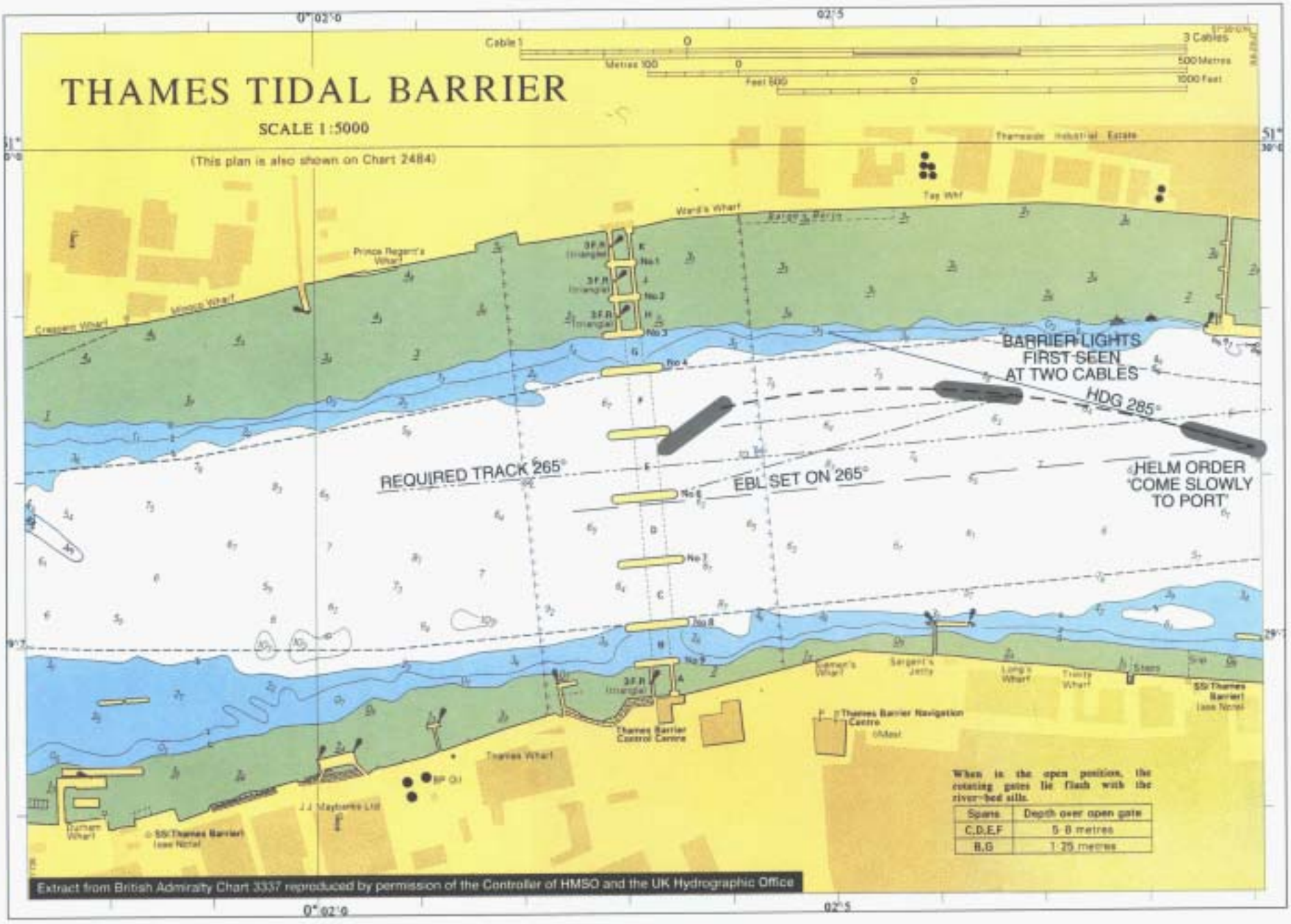


Figure 4: Radar – approach to barrier (N.B. readout shown *is not* from Sand Kite)


THAMES TIDAL BARRIER
SCALE 1:5000
(This plan is also shown on Chart 2484)
Cable 1
3 Cables
Metres 100
500 Metres
Feet 500
1000 Feet
Thamesside Industrial Estate
Tay Wharf
Ward's Wharf
Prince Regent's Wharf
Crossens Wharf
Windsor Wharf
3F.R (triangle)
No 1
No 2
No 3
No 4
No 5
No 7
No 8
No 9
BARRIER LIGHTS FIRST SEEN AT TWO CABLES
HDG 285°
REQUIRED TRACK 265°
EBL SET ON 265°
HELM ORDER 'COME SLOWLY TO PORT'
Thames Barrier Control Centre
Thames Barrier Navigation Centre
Thames Wharf
Durham Wharf
SS Thames Barrier (see Notes)
When in the open position, the rotating gates lie flush with the river-bed sills.
Spans | Depth over open gate
C,D,E,F | 5·8 metres
B,G | 1·25 metres
Extract from British Admiralty Chart 3337 reproduced by permission of the Controller of HMSO and the UK Hydrographic Office

substantial damage to the forward structure as all way came off the vessel. It was subsequently found that a number of tanks and spaces, including the forward pump room, had been holed (**Figure 6**).

Figure 6: *Sand Kite*'s damaged bow

At the time of the collision the able seaman on watch and the bosun were in the crew's messroom waiting to go to stations. On feeling the impact they immediately went out on the after deck and saw the concrete pier. Realising what had happened they went forward along the port side of the deck to provide whatever assistance they could.

Following the impact, and as the vessel started to move astern and clear of Pier 5, the mate broadcast a "Mayday" call on VHF Channel 14, which was acknowledged by Woolwich Radio. Moments later, with *Sand Kite* positioned across Foxtrot Span with her head to the south-west, the master thought he had an opportunity to take her through. He ordered ahead power and put the helm hard to starboard. The bow started to swing but before he could negotiate the passage through the barrier he noticed the bow "going down". *Sand Kite* was sinking.

The master was concerned that two of his crew were on the forecastle. The able seaman and bosun had reached the fore part of the vessel before they realised what was happening. They turned to retrace their steps and had climbed down from the forecastle only to discover they were cut off as the fore deck submerged. They noticed water gushing from the pump room air vents. The able seaman was washed over the side as the bow settled further, but was able to swim to the railings on the break of the forecastle where he joined the bosun standing waist high in water.

The master ordered the cargo emergency dump valves to be opened. The mate informed Woolwich Radio on VHF Channel 14 and asked for assistance from one of the line boats which had been standing by ready to assist *Sand* Kite during berthing.

Sand Kite suffered complete failure of her main electrical power supply when her forward switchboard became submerged.

The mate, on orders from the master, sounded the ship's general emergency alarm.

The two crew members on the forecastle were told that help was on the way. At the same time the remainder of the crew began to muster at their emergency stations. Although the control panel for the cargo dump valves indicated they were open, it appeared the cargo was remaining in place.

The situation seemed to stabilise with the bow settling on the ground between Piers 4 and 5 in Foxtrot Span and the aft part of the vessel remaining afloat alongside Pier 4 **(Figure 7).** The engine room staff were able to restore power to the after part of the vessel. The two crew members on the forecastle were rescued by one of the line boats and were taken aft where they were able to reboard and change their clothes. Soon afterwards most of the crew disembarked into the line boat and were taken ashore. Only the master and chief engineer remained on board.

Figure 7: *Sand Kite* blocking Foxtrot Span [photograph courtesy of FotoFlite]

The vessel was secured to Pier 4 using mooring lines and remained in the position in which she had settled. Some time later the master noticed the cargo was beginning to dump and asked the chief engineer to start the dedicated emergency power supply to enable the dump valves to be closed. The power supply was started and the valve controls were operated but the control panel continued to indicate the valves remained open.

During the day salvors were appointed and arrangements were put in hand to start discharging the remaining cargo. A full inspection of the damage to the vessel was started.

The salvors refloated *Sand* Kite on Saturday 1 November and took her, initially, upstream to Blackwall Power Station Jetty.

Diving inspections and hydrographic surveys in the vicinity of Foxtrot Span revealed that a large quantity of *Sand Kite*'s cargo was covering the barrier gate in its recessed sill. After careful consideration the aggregate was removed by specialist dredgers, whose dredging operation was completed on 6 November. Diving surveys conducted at night on 6 November and on the morning of 7 November, indicated that sufficient sand and gravel had been removed to safely move the gate. The operation of the gate was tested successfully between 1400 and 1700 on 7 November.

The testing and subsequent inspection of the gate confirmed the mechanism was undamaged, but the specially coated surface of the gate had suffered from the abrasion caused by *Sand Kite*'s movement on her cargo over several tides.

Sand Kite was towed to a repair yard in north-east England on 13 November. She was fully repaired and back in service by the end of February 1998.

1.3 REGULATION AND CONTROL OF RIVER TRAFFIC

1.3.1 The Port of London Authority – General Description and History

The PLA was established as a public trust under the Port of London Act of 1908 for the purpose of administering, preserving and improving the Port of London, and for other purposes including the conservancy of the Thames. The powers have been extended in subsequent acts and orders. Those of significance in this accident are:

(i) the Port of London Act of 1968, which gives very wide powers to the PLA in the administration of the Thames, including *Regulation of navigation by means of Thames bye-laws and directions to vessels on the Thames*; and

(ii) the Pilotage Act of 1987, which empowers the PLA as a competent harbour authority to make pilotage directions as the pilotage authority for the Thames.

1.3.2 Area of Jurisdiction

The PLA has jurisdiction over the entire tidal Thames from Teddington in the west to the outer Thames estuary in the east. The PLA's pilotage responsibilities are further extended seawards to include the approach channels to the Thames (**Figure 8**).

1.3.3 The Thames Barrier Navigation Centre (TBNC)

The PLA monitors the navigation on the river through the Thames Navigation Service control centres at Gravesend and Woolwich. These control centres provide an integrated Vessel Traffic Service to river users, radar coverage from beyond the seaward limit to Greenwich Reach and VHF radio cover throughout the whole area. The centre at Woolwich, on the south bank of the river just downstream of the barrier, is designated the Thames Barrier Navigation Centre and uses the radio call sign "Woolwich Radio". It has general responsibility for traffic upstream of Crayford Ness and, in particular, for the regulation of river traffic approaching, and passing through, the barrier. The TBNC, although under the control of the PLA, is publicly funded through the EA as a requirement under the Thames Barrier and Flood Prevention Act 1972.

The TBNC is manned day and night by one of five teams each consisting of at least two people: a marine officer, who is a master mariner, and a VTS operator. The teams work a

roster based on 12-hour watches which change daily at 0700 and 1900. A rest room, fitted with a bed, is provided for the use of one or other of the night duty TBNC staff at times when there are few movements through the barrier such as at low water. The operations room is never left unmanned.

Traffic movement through the barrier is largely governed by the state of tide. Much inbound traffic which is laden, needs to arrive on berths as soon as there is sufficient water so that as much time as possible is available to discharge before they sail on the ebb. Such traffic needs to pass through the barrier on the early flood tide. The aggregates dredgers such as *Sand Kite* fall into this category and pattern of trading. A number of regular traders, including *Sand Kite*, time their movements so they can arrive and depart on consecutive tides and discharge their cargoes over high water.

The relevant functions of the TBNC as laid down in the PLA's Thames Barrier Control Manual are:

- safety of navigation in general;
- control of navigation in the barrier control zone;
- co-ordination of shipping information;
- monitoring and regulation of traffic to ensure compliance with all regulations;
- the provision of more detailed navigational information and advice to vessels as appropriate.

The IMO definition of VTS is: A *service implemented by a competent authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.*

The main responsibilities of the marine officer at the TBNC which are pertinent to this accident, include:

- control and allocation of the barrier navigation spans;
- control of navigation in the barrier zone;
- providing navigational and any other appropriate information to vessels as requested or deemed necessary;
- ensuring the operations room is staffed to meet the prevailing conditions of weather and traffic;
- monitoring of Pilotage Exemption Certificate use.

To carry out his functions, the marine officer has the full delegated powers of the harbour master for:

- enforcing bye-laws and regulations;

- issuing special directions when necessary;
- control of traffic.

1.3.4 The Barrier Control Zone

The PLA has established a barrier control zone between Margaret Ness and Blackwall Point specifically to regulate river traffic in the immediate approaches to, and through, the barrier.

1.3.5 Reporting Points

To assist VTS operators in monitoring river traffic, designated reporting points have been established on the approaches to the barrier and when entering the barrier control zone. Inbound vessels are required to report as they pass Crayford Ness and enter the area controlled by the TBNC, and again when entering the barrier control zone at Margaret Ness. On entering the barrier control zone they are required to ask permission to pass through the barrier. They are then told which span to use.

1.3.6 Polaris

The details of all vessels using, or intending to use, the river are entered into the PLA's computer data storage system, Polaris, which records basic information about the vessel and her cargo, including dimensions, destination berth and departure/arrival times. The voyage record includes the time the tagged radar target passes each electronic way point. It also records details of the PEC holder registered for the passage being undertaken.

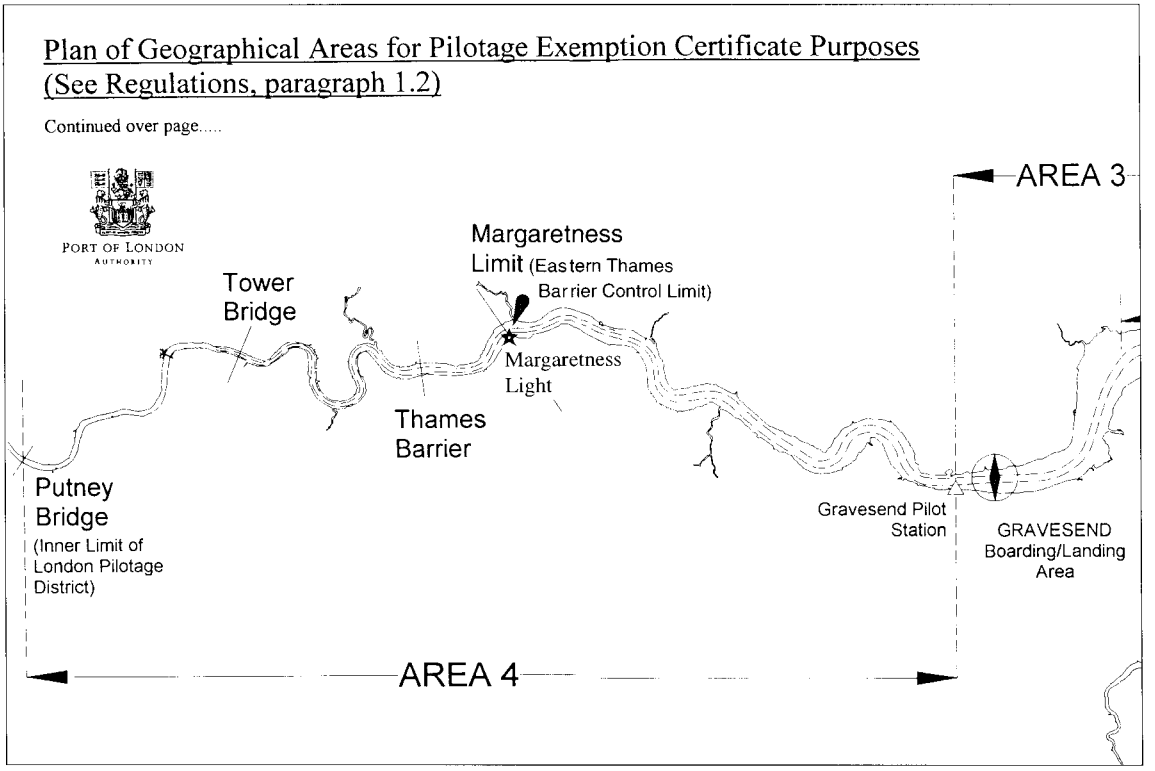
1.3.7 Radar Surveillance

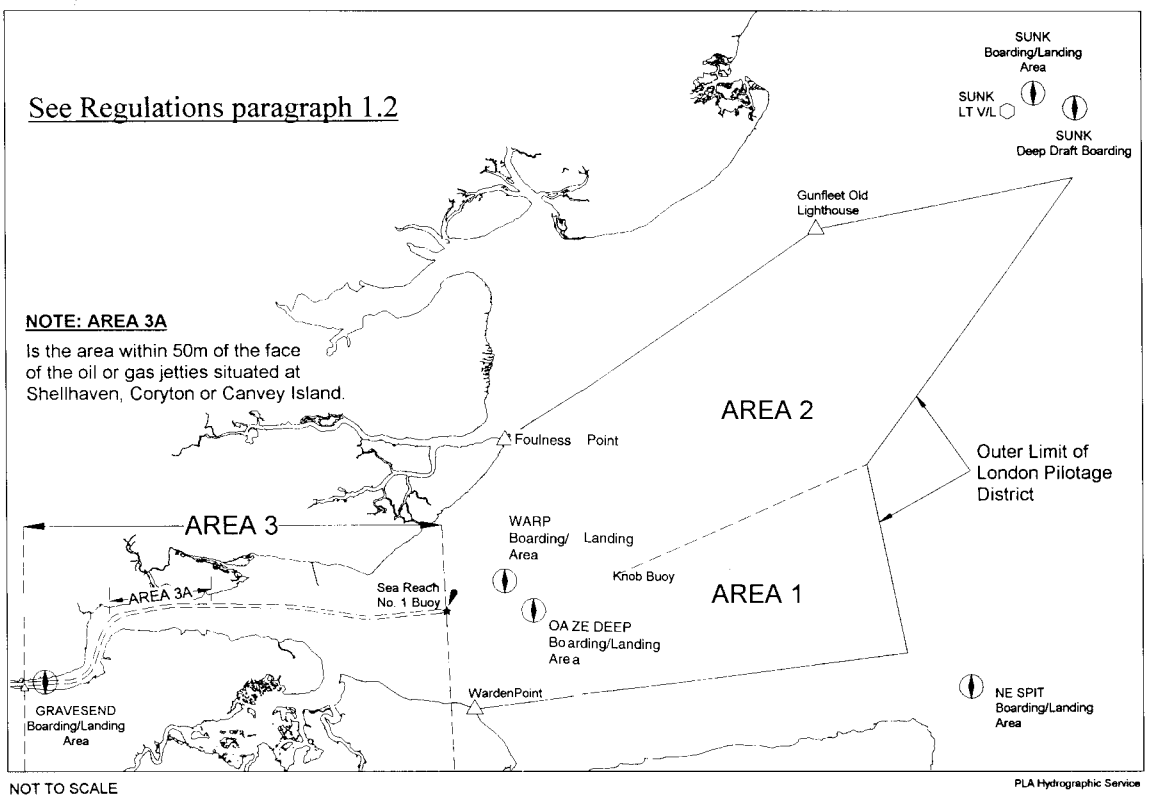
Radars at the TBNC, which are integrated with those at PCL at Gravesend, enable the duty staff to monitor the progress and position of vessels within the whole radar coverage area. When a vessel reports she is entering the PLA area inbound, or leaving her berth for the outbound passage, her radar target is "tagged" by VTS staff at either TBNC or PCL. The tag displays relevant information extracted from the Polaris data base. Once established, the tag tracks with the radar target and can be displayed on radar screens at the control centres. The computer calculates, from radar information gained over a short period, the course and speed made good over the ground, which can be displayed as a vector. Thus when a vessel alters course and/or speed the vector does not display the new information immediately.

The TBNC is charged with responsibility for radar surveillance of all areas between Crayford Ness and Greenwich. Four radar displays are available and are customarily arranged so that two at the marine officer's desk show the barrier and the reaches above the barrier under radar surveillance, whilst the VTS operator's show the barrier and reaches below to Crayford Ness. Each display has a split screen capability. The scale, and therefore range, can be varied on individual displays. To avoid clutter and to give a clear picture, the system suppresses the radar echoes from river banks and some other fixed objects on land. These key features are clearly depicted on the screens in the form of a computer generated and stabilised map. Radar echoes from the barrier are not treated in this way.

The radar tracked target data is routinely recorded but owing to a fault that had occurred during the previous night, the recording facility was not working on the morning of the 27 October.

Figure 8: **Plan of geographical areas for pilotage exemption certificate purposes**





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1.3.8 Radio Broadcasts

TBNC staff broadcast general navigational information for river users on VHF radio at 15 minutes and 45 minutes past each hour. These broadcasts routinely provide weather and visibility reports and forecasts, relevant information on the status of the barrier gates, special warnings and tidal data and information on vessel traffic.

1.3.9 Relevant Regulations

Vessels navigating on the Thames must, in general, comply with the International Regulations for the Prevention of Collisions at Sea as given effect by the Merchant Shipping (Distress Signals and Prevention of Collisions Regulations) 1996 (the Collision Regulations) which are incorporated within bye-laws of the PLA. In addition, vessels must comply with: general directions made under the Port of London Act 1968 (as amended); pilotage directions made by the PLA as a competent harbour authority under the Pilotage Act 1987; other bye-laws made under the Port of London Act; and local notices to mariners.

The following provisions, published as one of the above, some of which highlight relevant aspects of the Collision Regulations, are applicable on the river in general and relevant to this accident:

- *every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate to the prevailing circumstances and conditions so as to make full appraisal of the situation and of risk of collision;*

- *vessels of over 40m in length navigating above the barrier must, at all times, have a lookout stationed forward;*

- *no vessel shall at any time move in the Thames under automatic steering except where a competent person other than the master or pilot is available without delay to steer the vessel manually immediately circumstances so require ('without delay' should be interpreted to mean that a competent person shall be on the bridge with immediate access to the helm);*

- *mariners are reminded of the requirement to navigate their vessels at all times at a speed commensurate with local circumstances and conditions. Experience indicates that, in the area Gravesend Reach and above, a speed in excess of 10 knots through the water can be liable to injure or endanger persons, other vessels or property;*

[Note: there is no general speed limit on the Thames, although there is a speed limit of 8 knots which is imposed by bye-law in several named creeks and on the main river above Wandsworth Bridge.]

- *persons in charge of vessels navigating in any part of the Thames are reminded that they must comply with the rules concerning sound signals as given in the Collision Regulations;*

[Note: in this case – a power driven vessel making way through the water shall sound at intervals of not more than two minutes one prolonged blast.]

- *a vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.*

The following directions, which specifically apply to vessels navigating in the Thames Barrier control zone, are published by the PLA as notices to mariners and are of particular relevance to this accident:

- *vessels transiting the barrier must use the spans indicated by the traffic signals displayed at the barrier;*

- *no vessel over 350 feet (107m) in length will be permitted to navigate when the visibility at the barrier is less than half a nautical mile. Any such vessel must remain at her berth or anchor in a designated anchorage until such time as the visibility improves to over half a nautical mile;*

[Note: The limit of 107m stems from the historic requirement for such a vessel to have tugs for entry to West India Docks.]

- *any vessel wishing to overtake another vessel between the Woolwich Ferry terminal and the barrier inbound may only do so with the express permission of the TBNC;*

- *although, under normal circumstances navigation will be through one span in either direction, under certain circumstances, if a vessel makes the request, it may be possible to make a second span available;*

- *persons in charge of vessels are advised that at certain states of both flood and ebb tide, eddies caused by the presence of the structure may have an adverse effect on navigation;*

- *fog lights consisting of high intensity white lights will be in operation, in conjunction with the green arrow lights, when visibility is less than 0.5 miles.*

1.4 THE THAMES BARRIER

1.4.1 General Description and History

Throughout history, London has been subjected to periodic flooding during tidal surges. The risk of flooding has been steadily increasing as high tide levels have increased through a combination of factors, including more intense and frequent storms, increasing tidal amplitude, tilting of the British Isles with the south-eastern corner moving downwards, and settlement of the city on its bed of clay. High tide levels in central London are rising by about 0.6m every century. A serious flood would paralyse the city. Not only would many forms of transport be interrupted but essential services such as water, electricity, gas, sewage, vital telephone and data links carried underground would be damaged, while thousands of homes, shops and factories, businesses and buildings would be severely affected.

Recognition that improved flood protection for the tidal part of the Thames was absolutely necessary led to the decision to raise the river banks and build a flood barrier with moveable gates at Woolwich. The Thames Barrier and Flood Prevention Act was passed in 1972.

Work on building the Thames Barrier began in 1974. It became operational in 1982. It consists of a series of separate moveable rising sector gates positioned end to end across the river in Woolwich Reach. Each gate is pivoted and supported between massive concrete piers which house the operating machinery and control equipment.

Closing the barrier seals off part of the upper Thames from the sea. When not in use the gates rest out of sight in curved recesses in concrete sills on the riverbed, allowing free passage of traffic through the openings between the piers.

The width of the barrier from bank to bank is about 520m with four main navigable openings (spans), situated in the centre where the river is deepest and each having a clear span of 61m. The main gates are hollow steel plated structures over 20m high weighing, with counterweights, about 2700 tonne each and capable of withstanding an overall force of more than 9000 tonne. In addition to the four main navigable spans, there are six smaller ones of 31.5m width. The two adjacent to the main spans are navigable by small craft. The remaining four are non-navigable.

For identification purposes the spans are given letters in alphabetical sequence from south to north while the piers are numbered sequentially from north to south (**Figure 5**). Spans A, H, J and K are non-navigable, spans B and G are 31.5m wide with the main navigable spans of 61m width being C, D, E and F. Generally spans C and D, called Charlie and Delta, are used for outbound traffic and E and F, Echo and Foxtrot, for inbound traffic.

1.4.2 Thames Barrier Control Centre (TBCC)

The control of the barrier is exercised by the EA from the TBCC by a team of 75 permanent staff. The control centre is situated at the southern end of the barrier and is manned continuously (**Figure 2**).

The role of the TBCC's staff is to maintain the machinery and structure (including navigation lights), to monitor the likely need to operate the barrier and close it when necessary. The cost of running and maintaining the barrier is publicly funded through the EA. The EA staff at the barrier maintain regular communication with the PLA and, in particular, the TBNC regarding barrier operations and closures.

The barrier had been operated to protect London from flooding on 30 occasions since 1983.

1.4.3 Damage Control at the Barrier

Sand Kite came to rest on top of Foxtrot Span's barrier gate as it lay housed in its river bed recess. During the five days she remained there, Foxtrot Span was out of commission greatly reducing the potential effectiveness of the barrier. Fortunately the accident occurred at a time when it was unlikely that the gates would have to be raised to protect London from flooding.

TBCC staff became aware of the accident immediately and attempted to establish the extent of the damage. Superficial damage to the concrete of Pier 5 and to a metal ladder was visible but a full assessment could only be made once *Sand Kite* had been moved.

Contingency plans were drawn up in the event of having to use the barrier before *Sand Kite* could be moved. These included an "in extremis" plan whereby all other gates would be closed during the ebb tide so the force of water funnelled through Foxtrot Span would "blow" *Sand Kite* clear.

Following *Sand Kite*'s removal on 1 November and the successful dredging of her dumped cargo, a careful inspection for damage was made and trials of the gate's movement were undertaken. The survey indicated no damage to the mechanics but the abrasive action of the vessel moving on her cargo had scoured the paint coating on the gate itself.

1.4.4 Barrier Navigation Lights

The piers on either side of the navigable spans are fitted with an array of navigation signal lights. The designated spans for use by river traffic are indicated during day and night by means of a number of lamps arranged to give green arrow signals on either side of the span pointing inwards towards the opening. Spans closed to traffic are marked by lamps arranged in a red St Andrew's cross on the piers either side of the opening. In conditions of low visibility, the designated spans are additionally indicated by high intensity lights consisting of an array of 24 clear lamps arranged in six columns each of four lamps situated on the pier either side of the span. The high intensity lights are electrically interlocked with the green arrow "channel open" lights so that they can only illuminate if the appropriate "channel open" signal lights are on (Figure 9).

Figure 9: Navigation lights (span open)

The navigation and fog signal lights are controlled from the TBNC. Their status at any time is shown both at the TBNC and at the TBCC on mimic diagrams which give clear indication in the event of electrical or lamp failure. The signal and fog lights can be operated at any one of three levels of intensity, high, medium or low. The intensity selected is left to the discretion of the VTS officer.

A complex series of keyed interlocks ensure that it is impossible to show an "open" indication if the span is in the defence or maintenance position.

At the time of the accident the indicator and fog lights indicated Echo Span as the designated inbound span. The high intensity lights were on, all signal lights were switched to the highest intensity, the downriver side of all other spans indicated closed and there was no significant fault indications on either mimic diagram.

1.4.5 Previous Accidents at the Barrier

Approximately 33,000 transits of the barrier are made each year by river traffic of all sizes. Prior to this accident there had been 13 collisions necessitating repairs to the barrier. In addition, it is thought, there have been numerous other incidents of minor contact, many of which will have passed unrecorded. This accident is the most serious to date.

1.5 PILOTAGE

1.5.1 Compulsory Pilotage

The PLA, in exercise of its powers under the Pilotage Act 1987, has directed that pilotage is compulsory for all ships over 50m in length in the inner area, for specified vessels (broadly defined as vessels carrying dangerous cargo) and passenger ships over 50m, and all other ships over 80m in the outer area. The PLA may, however, grant "excepted ship" status to vessels between 80m and 120m in length which operate regularly in the outer area. Sea Reach 1 buoy lies on the dividing line between inner and outer areas (**Figure 8**).

Because she was not working entirely within the PLA's area, *Sand Kite* was not an "excepted ship". With her length of 98.68m and her requirement to navigate within the PLA's compulsory pilotage area, she was required to either carry an authorised pilot, or be under the pilotage of a master or first mate possessing a Pilotage Exemption Certificate (PEC) for the particular area she was in.

PECs are granted by the PLA in respect of an area, or part of an area, within the pilotage district as indicated in **Figure 8**.

Both mates in *Sand Kite* held valid PECs for areas 1, 2, 3 and 4 up to Angerstein's Wharf and the master held a PEC covering areas 1, 2, 3 and 4 up to Northfleet (just upriver from Gravesend). The master also had enough "credits" to apply for an extension to his PEC to cover area 4 up to Angerstein's Wharf but had not done so by 27 October 1997. At the time of the accident the master had control of the navigation of the vessel while the senior of the two mates, the holder of a valid PEC, was on the bridge steering the vessel.

Prior to the master's arrival in the wheelhouse at 0500 the vessel had been under the pilotage of the junior of the two mates who had registered the number of his PEC with PCL at about 0112. Neither PCL nor TBNC had been informed of any change in the registered PEC holder during the passage and, at the time the accident occurred, the Polaris computer system had the junior mate, who was asleep in his cabin, registered as the current PEC holder.

This inquiry has revealed uncertainty among both PEC holders and PLA staff as to how the Polaris system handles changes to the registered PEC holder when it occurs mid-pilotage. It was generally thought the system would only remember the last PEC holder registered. Because the Polaris system is used to verify that the required experience has been gained for PEC renewal, changes in PEC holder were often not communicated to PCL.

1.5.2 Pilotage Exemption Certificates (PECs)

Under the Pilotage Act 1987 a competent harbour authority, in this case the PLA, shall: *On application by any person who is bona fide master or first mate of any ship, grant a certificate* [PEC] *to him if it is satisfied (by examination or by reference to such other requirements as it may reasonably impose),*

(a) *that his skill, experience and local knowledge are sufficient for him to be capable of piloting the ship of which he is master or first mate (or that and any other ships specified in the certificate) within its harbour or such part of its harbour as may be so specified, and*

(b) *in any case where it appears to the authority to be necessary in the interests of safety, that his knowledge of English is sufficient for that purpose.*

A later section of the Pilotage Act states that: *A pilotage exemption certificate shall not remain in force for more than one year from the date that it is granted, but,*

(a) *if the holder continues to be the master or first mate of a ship, may be renewed annually by the competent harbour authority on application of the holder if the authority continues to be satisfied as quoted above, and*

(b) *on the application of the holder may be altered so as to refer to different ships from those to which it previously referred if the authority is satisfied as respects those ships.*

The PLA, under its Pilotage Direction No 2, brings these rules into effect and in so doing makes a distinction between vessels over and under 100m in length.

For vessels under 100m in length which do not carry dangerous substances, a master or first mate will normally be granted a PEC on written application to the PLA and without examination, provided the applicant is experienced in the navigation of the relevant area, holds a Certificate of Competency recognised by the PLA for the class of ship(s) concerned, has a satisfactory working knowledge of the English language, understands current local bye-laws and procedures and is medically fit. For the application to be successful this information needs to be substantiated in writing by the vessel's owner.

To satisfy the requirement that the applicant is "*experienced in the navigation of the relevant area*", it is necessary for the applicant to keep a "tripping log" which shows the number of times he has been on watch while the vessel has been navigating in the area concerned. For vessels under 100m in length, a specific minimum number of trips is not laid down but it is widely accepted to be the same as required for a vessel over 100m in length which requires an applicant to have made at least 12 trips during the previous 12 months involving six trips in and six trips out. All qualifying trips must be completed with a PLA pilot or valid PEC holder.

A PEC applicant for a vessel over 100m in length, in addition to the requirements stated above, must undergo a series of searching oral examinations similar to those required of a licensed pilot.

Many of the dredgers which frequently visit berths on the Thames, like *Sand Kite*, have a length just short of the 100m demarcation.

A PEC must be renewed every 12 months. The PEC holder must apply to the PLA stating that he has carried out four acts of pilotage during the previous 12 months (two inbound and two outbound) in the area(s) applied for, that he is aware of relevant changes affecting navigation in the area(s) concerned and that he remains medically fit.

Whether for renewal or on first application, the accuracy of the information given must be attested by the vessel's owner or manager.

On receipt of a PEC first application or renewal application, the PLA will usually compare the information given with information stored in Polaris to ensure the data in the system matches that stated in the application. These checks are made to ensure that, for first applications, the named vessel made the passages stated, and, for a renewal application, the registered PEC holder for each of the stated voyages was the applicant.

1.5.3 Comparisons with other UK Ports

Within the broadly stated requirements of the Pilotage Act, individual competent harbour authorities specify their requirements for PEC applicants to obtain or renew an exemption certificate. To gauge how the PLA's criteria for a PEC applicant on a general vessel of less than 100m in length compared with those of other ports, three were approached for information. Although common features were apparent, the detail varied widely. The requirements for Southampton, the Humber and the Clyde are summarised below:

Southampton

First applicants are required to undertake six trips in and six trips out with a pilot or PEC holder on board in the 12 months prior to the application, an oral examination by the deputy harbour master and one of his assistants, and a visit to the VTS control room.

Those seeking annual renewal are required to undertake three trips in and three trips out within the 12 months.

Humber

First applicants for a PEC covering the area to Hull Roads are required to undertake nine trips in and nine trips out *with a pilot* in the 18 months prior to application, and a one-hour interview with the pilotage manager to ensure the applicant knows the bye-laws, and for his competence to be assessed.

Those seeking annual renewal are required to undertake six trips in and six trips out within the 12 months.

Clyde

First applicants are required to undertake six passages in the previous year (at least two of which must have been made at night), to present for examination a properly prepared and compiled bridge book (must be original work) containing all local navigational information to include navigation marks, courses, distances appertaining to the area(s) for which they are applying and an oral examination conducted by the harbour master, or his deputy and an experienced Clyde pilot.

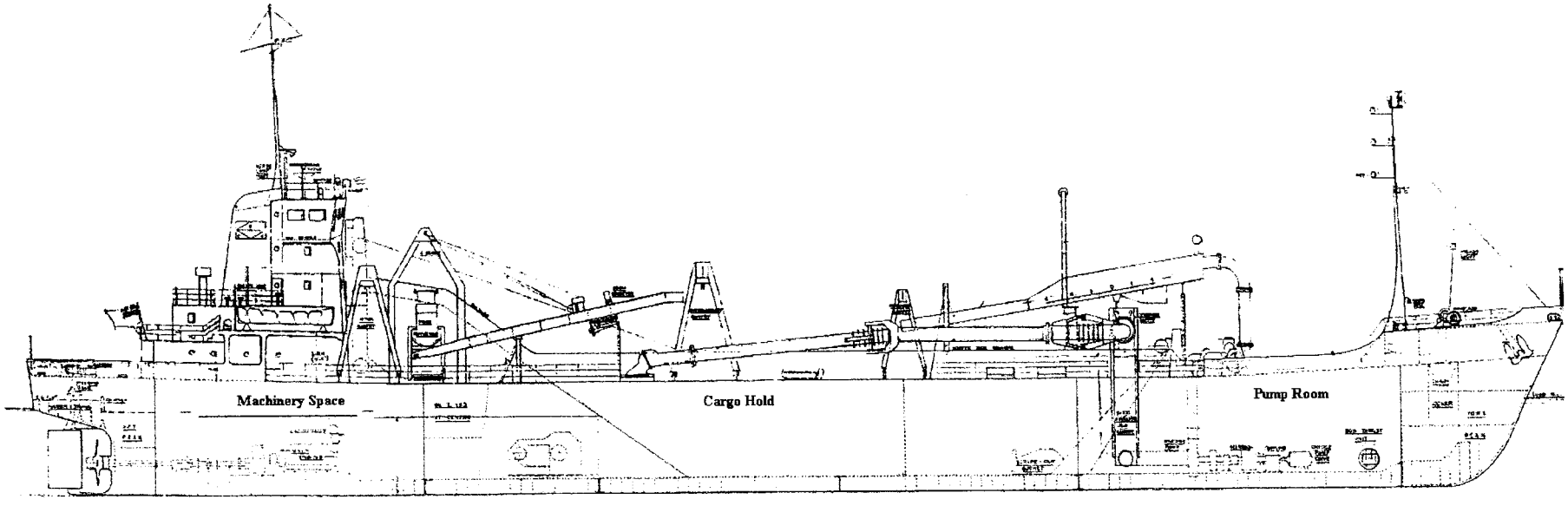
The PLA stand alone in this company as the only authority that does not require a licensed pilot to assess the performance of the applicant or for an applicant to be examined orally.

1.6 THE VESSEL

1.6.1 General Description

Sand Kite is a trailing suction dredger with a mechanical discharge facility incorporating a shore delivery boom. She is designed with superstructure aft, cargo hold and handling equipment forward (**Figure 10**).

Figure 10: **Profile of *Sand Kite***



Within the hull, at the after end, is a machinery space with two Rushton diesel engines driving a single shaft with a controllable pitch propeller. Forward of the machinery space there is a winch room from where wires are led to mechanical discharge scrapers in the cargo hold. *Sand Kite* has a single open hold of nominal capacity 3,800 tonne. A large pump room spans the width of the vessel between the forward bulkhead of the hold and the collision bulkhead. Forward of the collision bulkhead there is a forepeak tank.

On the main deck forward is a forecastle space with storerooms and chain lockers. The dredging equipment is located further aft the deck adjacent to the main hold. The main suction arm and its associated gantries lie to starboard of the hold. A walkway, situated on the port side of the hold, provides access from aft to the foredeck and forecastle. Aft of the hold, the main superstructure houses accommodation for the officers and crew, and the wheelhouse. The height of the superstructure enables a good view to be obtained from the wheelhouse forward over the hold, forecastle and dredging gear. The horizontal distance between the wheelhouse front and the stem is approximately 79m.

1.6.2 Wheelhouse Layout and Equipment

On the forward bulkhead of the totally enclosed wheelhouse (**Figure 11**) is a wide central console unit which houses the main navigational and control equipment. On the port end of the console are two data recording instruments which are interlocked with dredge control functions, so that basic navigational information including time and position are recorded during dredging operations. These were not recording at the time of the accident. The main steering position is sited centrally on the console enabling the helmsman to have a good view forward (**Figure 11a**). The autopilot is mounted just to port of the main wheel. A computer visual display unit (VDU), which is also sited to port of the steering position, is capable of showing rudimentary maps that have been drawn by the vessel's officers. A differential global positioning system (DGPS) input to the computer enables the vessel's current position, course and speed to be displayed on the VDU overlaid on the map (**Figure 11b**). The overall accuracy achieved by the unit is poor and although it will give the helmsman an approximate indication of the vessel's position relative to land or navigational features, it is of little use in pilotage waters. To starboard of the steering position are engine controls and, at the starboard end of the console, the main VHF radio and Kelvin Hughes HR2044 radar. Another radar, a Kelvin Hughes Nucleus 5000R, is mounted at the end of the console on the port side of the wheelhouse (**Figure 12**).

The chart table is situated 2m back from the bridge front on the starboard side of the wheelhouse.

A summary of the principal bridge navigational instruments follows:

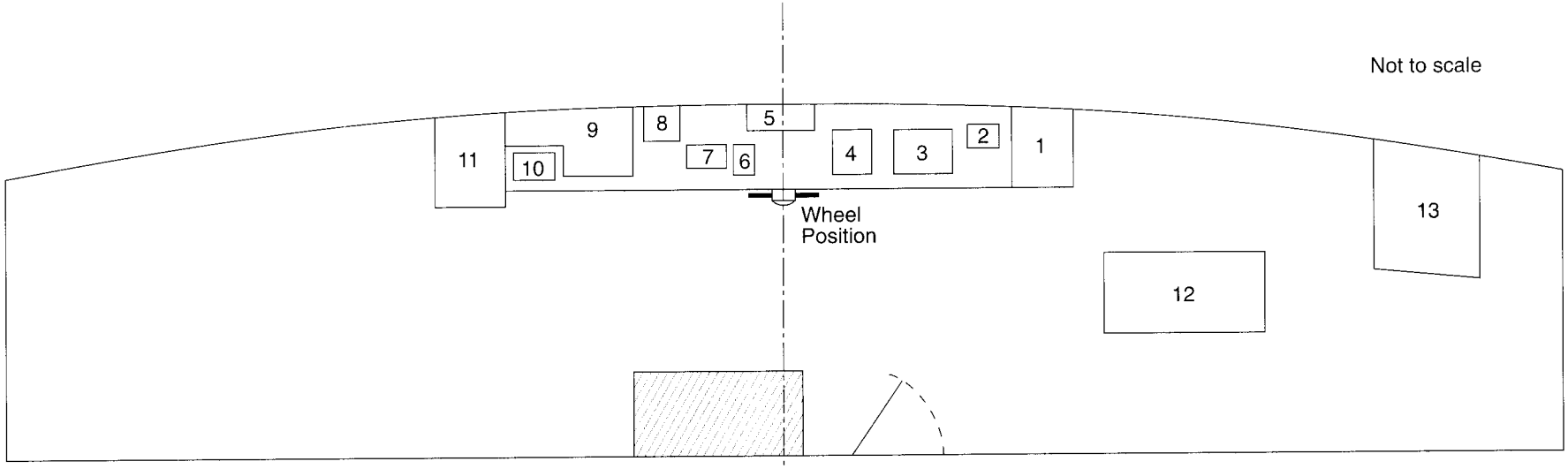
Radar	Kelvin Hughes	HR 2044
Radar	Kelvin Hughes	Nucleus 5000R
Auto pilot	Racal Decca	Type 450
Gyro Compass	Sperry	Mk 37
DGPS	Sercel	NR 50
GPS	Sercel	Syledis Vega
Decca Navigator	Racal Decca	PCC 2130
VHF Radio	Sailor	Compact RM 2042

Figure 11: The bridge – general view of wheelhouse

Figure 11a: Wheel position

Figure 11b: VDU sited close to wheel position

Figure 12: **Wheelhouse instruments [Approximate location of selected instruments]**



KEY

1 HR2044 Radar
2 VHF Radio
3 Propulsion controls
4 Engine indicators
5 DGPS
6 Internal telephone
7 Auto pilot
8 VDU-Map display
9 Data recording systems
10 Gyro compass
11 Nucleus 5000R Radar
12 Chart table
13 Dredging desk

The master of *Sand Kite* preferred using the starboard radar. Although it is an older and less advanced model than the Nucleus 5000R radar sited on the port side, the HR 2044 radar's location close to VHF radio and chart table, and its more familiar knob and switch controls, makes it the preferred radar for all the officers questioned.

During the river passage on the morning of 27 October, the heading shown on the starboard radar had been checked against the gyro compass and was found to be accurate to within a degree.

Sand Kite does not have a specific speed measuring instrument. Speed over the ground is obtained from the DGPS display situated to port of the helmsman.

Although the starboard radar has an electronic plotting aid it does not have a GPS input. Vessel speed, if required, must be fed in manually.

The starboard radar has an electronic parallel index feature but, as the facility does not have a memory, parallel index lines must be arranged as and when required.

1.6.3 Certification

At the time of the accident the vessel was fully certificated in accordance with national and international regulations.

1.7 THE CREW

1.7.1 Complement

On 27 October *Sand Kite* had a total crew complement of 13, including two engineer cadets. The Safe Manning Certificate, which was issued by the Marine Safety Agency on 10 April 1992, indicates the minimum safe manning to be nine persons (**Figure 13**).

The crew worked a routine of three weeks on duty followed by three weeks leave. Two full crews were appointed to the vessel. They were generally rostered to work in whole crew teams with the majority of each being relieved at the same time. To provide some continuity at crew changeover times, one deck officer and one engineer officer changed over one week after the rest of their team.

The master was 44 years old at the time of the accident. He first went to sea as a deck rating in 1974 and had been working on dredgers since about 1982. He became a deck officer in about 1983. He holds a Certificate of Competency Class 4 Deck. He gained a Command Endorsement – Limited European in 1988. He sailed as master for one year with another dredging company before joining South Coast Shipping Co Ltd in 1989 as a first mate. He was promoted to master with South Coast Shipping Co Ltd in 1994, first serving as relief master on various dredgers before being appointed as one of the permanent masters of *Sand Kite* about six weeks before the accident. Since then he had served one week of the previous period of duty followed by three weeks leave, before rejoining the vessel with the majority of the crew on 15 October. He holds a valid PEC for the outer areas of the pilotage district and in the river as far as Northfleet. He had been through the Thames Barrier as master on *Sand Kite* about four or five times prior to the accident. In the past, when he was mate of *Bowtrader* he had held a PEC for all areas to Tower Bridge, including the barrier, and had often passed through the barrier over a period of about nine months. The master had the con at the time of the accident.

Figure 13: **Safe manning certificate for United Kingdom registered sea-going ship**

MAN 2 *(Revised 1990)*

THE DEPARTMENT OF TRANSPORT

Safe Manning Certificate for United Kingdom Registered Sea-Going Ship

The Department of Transport hereby state that in their view the ship named in this certificate will be considered to be safely manned within the meaning of the Merchant Shipping Acts provided that when going to sea the ship has not less than the numbers and grades of the personnel shown in the following table and that the special conditions, where inserted, are observed. The manning assessment takes into account the Principles of Safe Manning contained in IMO Resolution A481 (xii).

Attention is drawn to the provisions for sailing short-handed and to the illustrative map of the Trading Areas reproduced overleaf.

Nothing in this certificate invalidates any provision as regards the carriage of certificated personnel as prescribed in:-

* (a) the Merchant Shipping (Certification of Deck Officers) Regulations 1985
(b) the Merchant Shipping (Certification of Marine Engineer Officers and Licensing of Marine Engine Operators) Regulations 1986
(c) the Merchant Shipping (Certification of Ships' Cooks) Regulations 1981
(d) the Merchant Shipping (Ships' Doctors) Regulations 1981
and (e) the Merchant Shipping (Radio Installations) Regulations 1980

Applicant

This certificate is valid only in relation to the particulars of the ship shown, and the nature of the service stated, in the application form completed by

EAST COAST AGGREGRATES LTD

Dated 14 January 1992

Ship

Name of ship: SAND KITE ~~"BOW KNIGHT"~~

Port of registry: CARDIFF

Official number: 361446

Gross Tonnage: ~~2965~~ 3110

Registered power (kW): 3450

Type of manning system: CONVENTIONAL

MARINE SAFETY AGENCY NEWCASTLE UPON TYNE MSA

Special Conditions

1. The Category 3 seaman may be substituted by a Third Engineer Officer or a Cook who hold steering certificates, have satisfactory experience as bridge lookout and agree to work on deck as required.

2. A lone watchkeeper should not attend the machinery spaces unless a suitable watch alarm is operational.

Signature: J M SCHULTZ

Date: 10 April 1992

For and on behalf of the Department of Transport

Personnel

	Limited European	Extended European	Unlimited
Master	1		
1st Mate	1		
2nd Mate	1		
3rd Mate	-		
Category 1 Seaman	-		
Category 2 Seaman	2		
Category 3 Seaman	1		
Radio Officer	-		
Chief Engineer	1		
2nd Engineer	1		
3rd Engineer	-		
4th Engineer	-		
Assistant Watchkeeper	-		
Limited Duty ER rating	1		
Cook	-		
Doctor	-		
	-		
	-		
Total minimum number of crew to be carried	9		

* (a) SI 1985/1306 (as amended)
(b) SI 1986/1935 (as amended)
(c) SI 1981/1076
(d) SI 1981/1065
(e) SI 1980/529 (as amended)

Department of Transport
DSG 3(B) (6th floor)
Sunley House
90/93 High Holborn
LONDON WC1V 6LP

The senior mate was 53 years old at the time of the accident. He started his career at sea in 1976 and had served with various dredging companies since that time. He obtained a Certificate of Competency Class 3 Deck in 1982 and later obtained a Command Endorsement. He served as master on dredgers operated by East Coast Aggregates and then South Coast Shipping Co Ltd between 1989 and 1994. After having been made redundant in 1994 he was re-employed as first mate. He was appointed as permanent first mate of *Sand Kite* in January 1996. The senior mate had held a PEC for the Thames up to Angerstein's Wharf continuously since about 1984. He was steering the vessel from the wheel position in the wheelhouse at the time of the accident.

The junior mate was 56 years old at the time of the accident. He holds a Certificate of Competency as first mate Foreign Going which he obtained in 1965. After a period working ashore he revalidated his certificate in 1991 and joined South Coast Shipping Co Ltd. He has worked as the junior of the two mates on board *Sand Kite* since that time. He had held a PEC for the Thames to Angerstein's Wharf for about five years prior to the accident and it was his PEC that was registered with PCL. He had left the wheelhouse about half an hour before the accident.

In addition to the above officers, the crew complement was made up as follows:

- chief engineer officer;
- second engineer officer;
- two third engineer officers;
- two engineer cadets;
- bosun;
- two able seamen;
- cook.

1.7.2 Watchkeeping

The two mates alternated as bridge watchkeepers, each working six hours on duty followed by six hours off duty. This routine applied whenever the vessel was operational: loading or discharging as well as on passage. The watch changeover times were 0000, 0600, 1200 and 1800. Due to the length of each watch, and because they had duties outside bridge watchkeeping times associated with the implementation of the International Safety Management (ISM) Code, there was a reluctance on the part of the master to make further use of the off-watch mate.

In addition to his general administrative duties, the master performed the principal acts of pilotage and was in control during loading. On the Thames the master was always on the bridge when upriver of Gravesend.

The two able seamen each worked eight hours on followed by eight hours off. Watch changeovers took place at 0400, 1200 and 2000. If not required for lookout duties in the wheelhouse, the able seamen were employed about the vessel or allowed to stand by in the messroom. Due to the long period on duty they were not required to act as lookout by the watchkeeping officer unless the circumstances dictated it was essential.

The bosun worked a daywork routine and, outside daywork hours, when needed during pilotage and cargo operations. He did not, as a rule, take a part in bridge watchkeeping.

1.7.3 Master's Standing Orders on Watchkeeping

The master had been appointed in a permanent capacity on *Sand Kite* a short time before the accident, and had not produced his own standing orders to watchkeepers. His colleague, the master on the other team, had written standing orders to bridge watchkeepers which were posted in the wheelhouse. Those orders had been signed as having been read by deck officers, including the senior mate and the master himself who, when he signed the document in December 1996, had been acting as an additional master on board.

Among other things the master's standing orders state that, *during the hours of darkness the duty seaman is to be the lookout on the bridge.*

1.7.4 Company Instructions on Watchkeeping and Lookout

The following instructions, which have been extracted from South Coast Shipping Co Ltd's company operations book, are particularly relevant to this accident.

During the hours of darkness and in reduced visibility the duty rating to be on lookout duty.

The master should be present on the bridge when weather, navigational hazards, etc, require him to be there.

As a general rule the master and watchkeeping mate should both be on the bridge in areas of close pilotage. This may be varied at the master's discretion as circumstances and conditions dictate.

The watch officer should at all times comply with the current International Regulations for Preventing Collisions at Sea. He should bear in mind the requirements to proceed at safe speed having due regard to the circumstances and conditions.

The watchkeeping mate must at all times ensure that an efficient lookout is maintained by sight and hearing as well as by all available means appropriate to the prevailing circumstances and conditions.

As a general rule for vessels in pilotage waters and within port limits, a lookout shall be posted forward.

When a vessel is navigating through bridges, or in a particularly confined area where close quarter situations could develop quickly, a mate and a deck rating must be posted forward as lookouts. The watchkeeping mate will still carry out his duties from the bridge. When a vessel is in the Thames a lookout must be posted forward when navigating above Woolwich Ferry. However, at the master's discretion, this lookout need not be a mate.

It cannot be emphasised too strongly that the foregoing is to be regarded as a minimum lookout requirement for navigation in pilotage waters and within port limits.

1.7.5 Lookout and Helmsmen

The Standards of Training, Certification and Watchkeeping for Seafarers Code adopted in IMO in July 1995 and as brought into UK law by the Merchant Shipping (Safe Manning, Hours of Work and Watchkeeping) Regulations 1997 states:

A dedicated lookout must be posted at night. During daylight hours the watchkeeping officer can act as the sole lookout providing on each occasion the situation has been carefully assessed and it has been established without doubt, taking into account all relevant factors, that it is safe for him to do so.

The duties of helmsperson and lookout are separate and the helmsperson shall not be considered to be the lookout while steering, except in small ships where an unobstructed all-round view is provided at the steering position.

The able seaman lookout was sent below at 0530 to measure cargo and make preparations for arrival. He returned to the wheelhouse at about 0615 and, having delivered a message and found out where the vessel was, went below to call the bosun and to await further instructions. In the master's experience on *Sand Kite*, the mate generally called the seaman to go forward when the vessel passed the Woolwich Ferry, an arrangement that complied with company instructions. This was not a fixed procedure however, and when the accident occurred the on-watch able seaman was still in the messroom waiting for the call.

The seamen on *Sand Kite* were very rarely used as helmsmen. It was generally preferred that the mate on watch took the wheel when necessary. This routine has led to the seamen getting out of practice. The master had recognised this shortfall and had, in the past, encouraged routines whereby seamen received more steering practice. In the situation on 27 October, however, he did not have confidence to use the seaman as helmsman as he was unsure how recently he had gained such experience.

1.7.6 Hours of Rest

In the 36 hours prior to the Monday morning of the accident, the master had managed four and a half hours sleep over Saturday night, three hours during Sunday afternoon and six hours during Sunday night.

The senior mate, the mate on watch at the time of the accident, had been working the normal six hours on/six hours off watchkeeping routine and had woken from six hours rest an hour before the accident.

1.7.7 Alcohol/Drugs

South Coast Shipping Co Ltd operates a strict no alcohol/drugs policy aboard its ships.

The master voluntarily submitted to a breathalyser test, which was carried out by the PLA, soon after the accident. The test proved negative.

There is no evidence to indicate that drugs were, or were likely to have been, a factor in this accident.

1.8 NAVIGATION AND THE APPROACH TO THE BARRIER

1.8.1 Conduct of Navigation

In clear visibility and in pilotage waters, the navigation of *Sand Kite* is generally conducted by eye with supporting information provided by radar. This is common practice in most similar vessels. Positions are rarely plotted on the chart but times of passing key features are entered in the log book. The chart would normally be spread out on the chart table and referred to in the event of doubt. Some individual PEC holders, including the junior of the two mates on *Sand Kite*, have their own written pilotage passage plan which includes, among other things, information on suitable anchorages.

In poor visibility more reliance is placed on radar navigation as the primary method with visual information being used whenever possible.

On the morning of 27 October the master had the con from about 0500 and was navigating using the radar and his intimate knowledge of the river, with occasional reference to the chart, compass and GPS position. No special preparations for blind pilotage had been made, apart from the agreement on the rudimentary division of responsibilities which was reached soon after the master had taken the con.

Indications of the visibility at various points in the river and reports of other vessels' activities were overheard on the VHF radio as other vessels spoke to one another or with TBNC or PCL.

1.8.2 Alignment and Position of the Barrier

The river flows broadly east/west in Woolwich Reach and is fairly straight for about 1.6 miles, with only a slight northerly bow. An inbound vessel following the alignment of the river must steer to the north of west until abeam the Refinery Jetty when she turns to the south of west to steer 265° through the barrier, which is aligned 175°/355° directly across the river about 0.35 miles west of the Refinery Jetty (**Figure 14**).

To transit the barrier safely it is advisable to line up with the designated span and steady on a course of 265° as early as possible. Due to the bow in the river it is not possible to line a vessel up on Foxtrot Span (one of the normal spans designated for inbound traffic) until after the Refinery Jetty has been passed, and masters prefer to use Echo Span, especially in poor visibility. However, even for Echo Span, it is necessary to wait until the Refinery Jetty is abeam before aligning on the required course of 265° through the barrier. The situation is exacerbated when the presence of a vessel alongside the Refinery Jetty causes inbound vessels to stay further south in the river until past the jetty.

Particularly large inbound vessels wishing to transit the barrier are sometimes designated Delta Span to give more distance in which to accomplish and check this alignment.

1.8.3 The Use of Radar

When approaching the barrier in poor visibility, safe navigation is based on information obtained from the vessel's radar until such time as the high intensity and signal lights on the piers can be seen. In particularly poor visibility it may be necessary for the master or pilot to line the vessel up on the designated span using radar alone.

Radar echoes from targets on the river banks tend to be difficult to distinguish but jetties are readily identifiable. In particular, Woolwich Ferry terminals are easily identified on the approach to the barrier and provide a suitable feature on which to parallel index.

The Thames Barrier forms a very good radar target at short range but, because of the narrowness of the spans, the pier echoes tend to merge with one another when seen from longer ranges. From the eastern end of Woolwich Reach the barrier is displayed as an almost continuous line across the river. As a vessel closes the barrier, good differentiation can be obtained in time to assist the master or pilot line-up for the transit providing short pulse has been selected and the radar picture is correctly set up. The larger piers marking the navigable spans are readily distinguishable from the others [or smaller ones] making it reasonably easy to identify the designated span (**Figure 15**).

1.8.4 The Effect of the Tidal Stream

On 27 October, high water at London Bridge was 1109 and low water at 0445. It was a period of neap tides.

Figure 14: **Woolwich Reach**

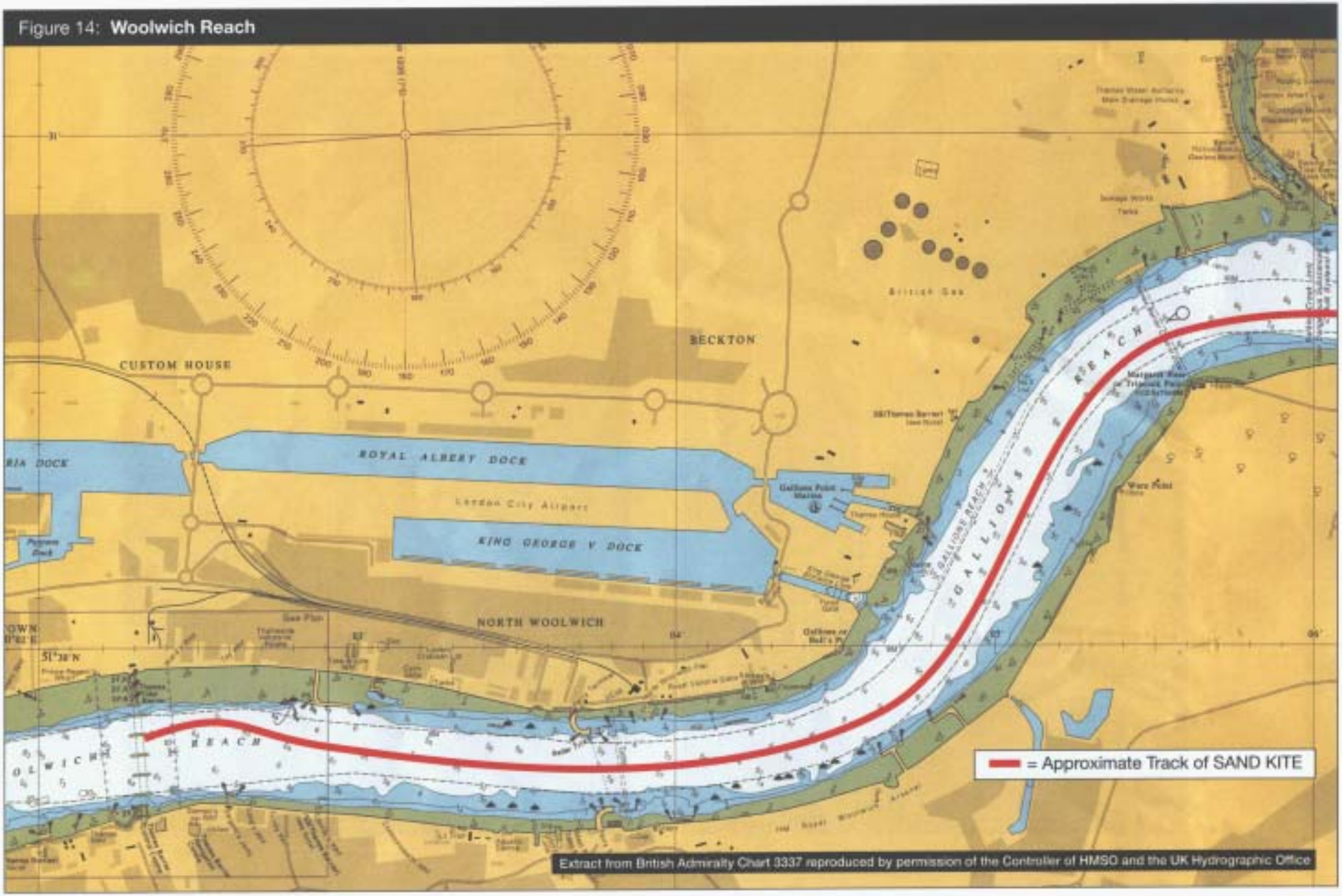
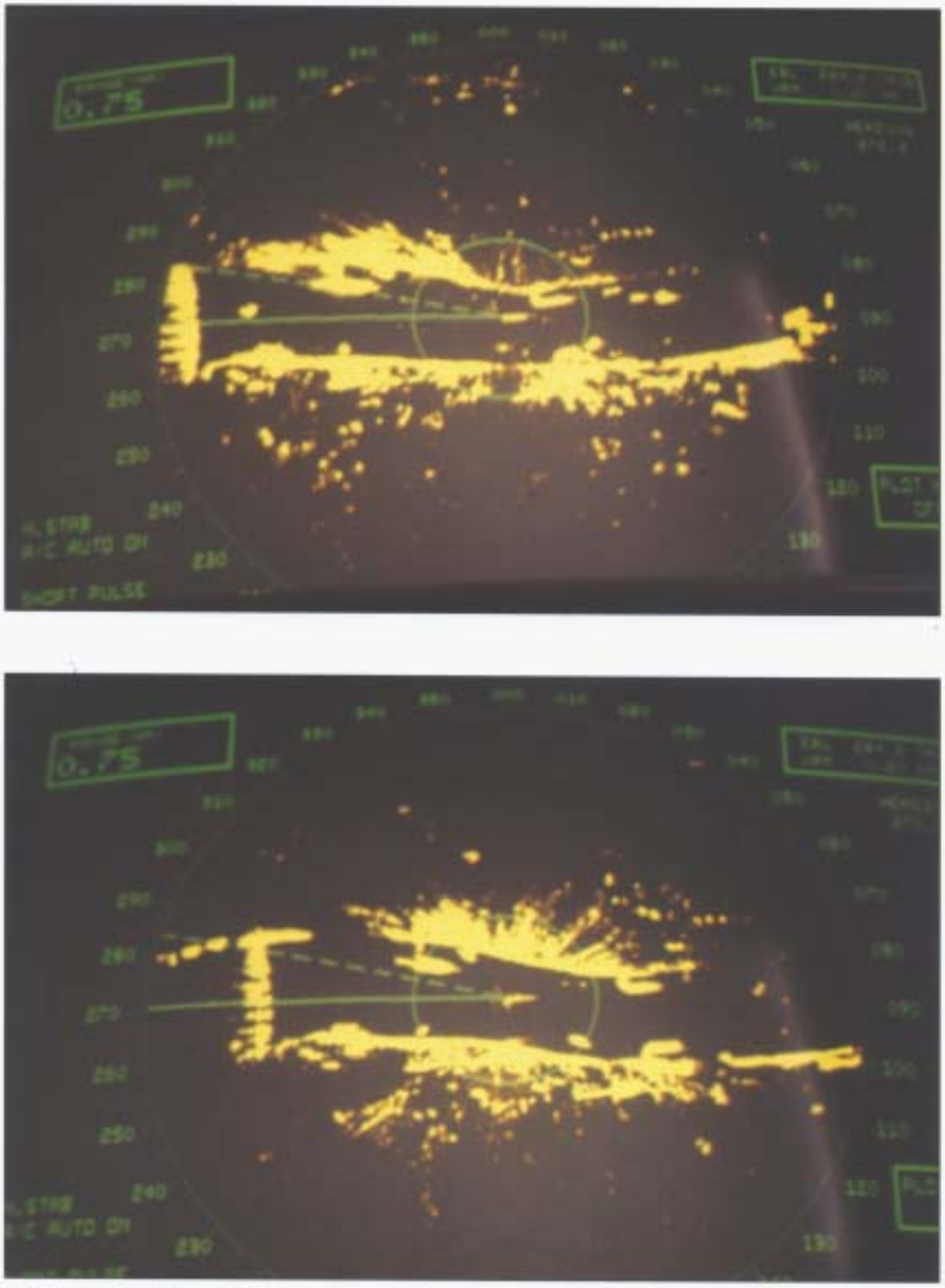
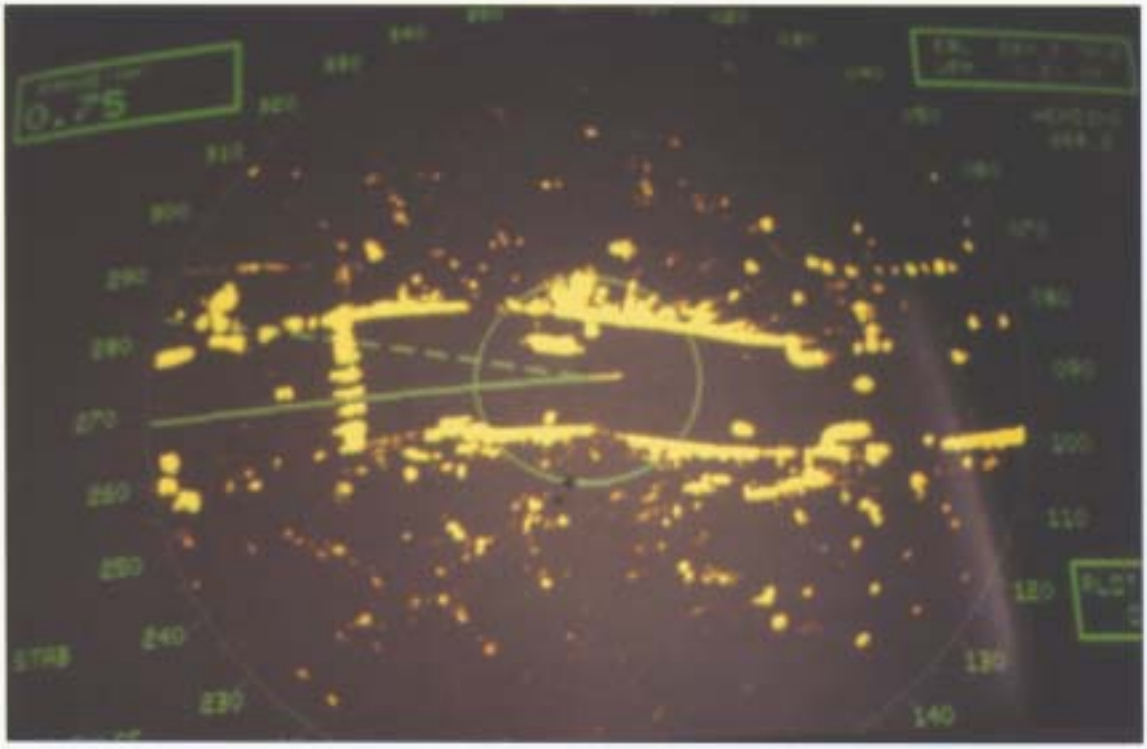


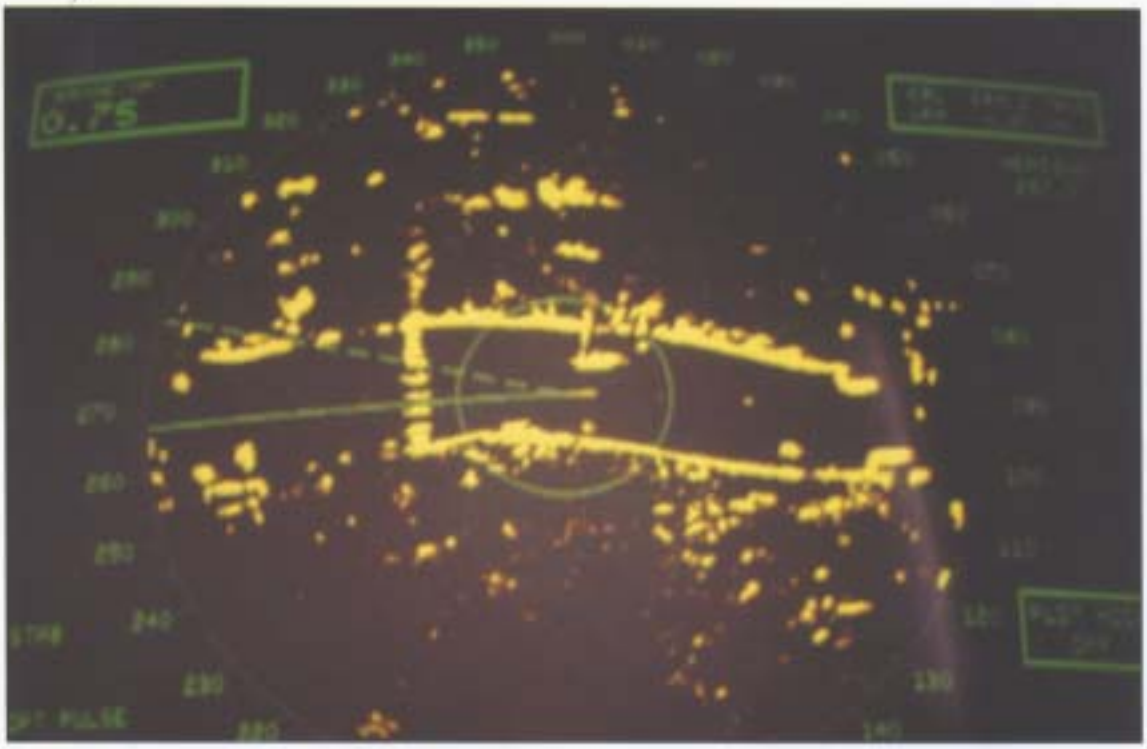
Figure 15: **Approach to barrier (display *not* that of *Sand Kite*)**



Note: Delta Span designated; EBL set on 285; variable range marker (VRM) set on 0.2 miles and range 0.75 miles

Figure 15 (continued): **Approach to barrier (display *not* that of *Sand Kite*)**





The majority of inbound river traffic at the barrier occurs before high water as vessels come upriver with the flood tide. A master or pilot of a vessel approaching the barrier will adjust the speed through the water to the minimum necessary to maintain good control of steering while allowing the maximum time to align with the span. The vessel's speed over the ground, or the speed with which she is closing the barrier, will be the speed through the water plus the speed of the flood tidal current. At the time of the accident the tidal current was estimated to have been between 1 and 1.5 knots, which contributed to *Sand Kite*'s speed over the ground of 6–7 knots. *Sand Kite* covered the distance between the Refinery Jetty and the barrier in about 3.2 minutes.

The slight bow in the river to the east of the barrier has the effect of causing a very slight cross river, north to south, component in the direction of the tidal stream on the immediate approach to the barrier. Masters and pilots allowing for this cross element to the tidal stream may take their vessels slightly to the north of the direct alignment with the span, so the current can bring the vessel into direct alignment as they close the barrier. Alternatively they may steer slightly to the north of the required course of 265° to maintain the direct line despite the current.

1.9 ENVIRONMENTAL DATA

1.9.1 Weather Information

The shipping forecasts issued by the Meteorological Office timed at 2358 on 26 October and 0505 on 27 October, which includes the estuary but not the river, did not indicate fog in sea area Thames. Both forecasts were for winds from the south-east force 3 or 4, occasional rain or drizzle and moderate or good visibility.

The regular VHF broadcasts at 15 and 45 minutes past each hour from Woolwich Radio at TBNC include local weather information. The statement that fog was affecting many reaches of the Thames was included in all broadcasts transmitted during *Sand Kite*'s approach to the river.

The mate on watch in the early hours of Monday morning, the junior mate, became aware that fog was being forecast for some reaches of the Thames. He called the master slightly earlier than usual and posted the seaman as lookout in the wheelhouse.

On entering the Thames, the officers on *Sand Kite* were able to receive frequent visibility reports by listening to other vessels reporting in by VHF to either TBNC or PCL.

The visibility in the vicinity of the vessel during *Sand Kite*'s river passage was patchy, and varied from less than 0.2 miles to over 0.5 miles.

At least one vessel, which passed through the barrier before *Sand Kite*, reported to TBNC that the signal lights were first seen at 0.2 miles. Not having heard this report, the master was expecting to see the lights earlier but, in the event, he, too, was unable to see them until the vessel was 0.2 miles from the barrier.

A few minutes after the accident the visibility at the barrier improved.

1.9.2 Sunrise

Sunrise on the morning of 27 October was at 0645, three minutes before the accident.

SECTION 2
Analysis

2.1 GENERAL COMMENT

Sand Kite collided with the Thames Barrier in dense fog. At the time:

- the barrier navigation and fog lights were working correctly and set at high intensity;
- the machinery and instrumentation on *Sand Kite* functioned correctly;
- a PEC holder was on the bridge;
- *Sand Kite* had been following the accepted practices of the river during the pilotage in respect of her speed and overtaking manoeuvres;
- the TBNC was fully manned;
- the TBNC traffic monitoring and communications equipment were functioning correctly.

Given these factors, the MAIB inquiry set out to investigate the organisational and navigational ability of the master, the Port of London's system of issuing, monitoring and managing its PECs, and the regulations, directions and bye-laws under which *Sand Kite* was operating. In addition, the inquiry looked at the functions and conduct of watchkeepers in the TBNC and the adequacy of navigation aids on the barrier, including the lights.

2.2 BRIDGE TEAM ORGANISATION

Sand Kite's deck manning met the statutory minimum safe manning requirement. Engine room manning, with two engineer cadets embarked, was in excess of minimum requirements. On 27 October her master and two deck officers were appropriately qualified and experienced and she carried an experienced bosun and two able seamen. The master would normally have been expected to hold a PEC for frequently visited ports, including the Thames pilotage areas to Angerstein's Wharf. The bridge routines were arranged on this basis.

The passage from the River Thames entrance to Angerstein's Wharf requires frequent course alterations. In normal circumstances and in clear visibility, the mate on watch would steer *Sand Kite* using the autopilot or wheel, but would often hand over to the master for close manoeuvres including the transit of the Thames Barrier. The seamen were used rarely, if ever, as helmsmen. Navigation was usually conducted by eye with occasional reference to the chart.

In clear visibility, course alterations were usually made by the mate on watch without instruction. He would have a good view forward from the wheel (or autopilot) position and would know the river. The arrangement enabled the mate's performance to be monitored by the master and in clear visibility it worked satisfactorily.

On the morning of 27 October, and despite the known presence of fog and the limitations on the master's PEC, which was only valid to Northfleet, the watchkeeping routine for the pilotage up the Thames remained unchanged from that generally operated in clear visibility. The bridge was manned by the watchkeeping mate and the master and, in the early stages, the watchkeeping seaman.

Due to the poor visibility on 27 October, the mate on the helm was reliant on directions from the master. He had no direct sight of a radar and the map display on the VDU was insufficiently accurate to be used for safe navigation. The master's attention was focused on navigation and giving helm orders to the mate. Additional responsibilities included monitoring the VHF and maintaining a lookout and performing the more general functions in his capacity as both master and pilot. As the demands of an individual's workload increase, the standard of performance typically increases until an optimum level is achieved. If this is exceeded, research shows that important information will be missed due to the focusing of attention on to a narrow range of functions.[1] The evidence in this investigation reveals that the master failed:

- to recognise the probability that he would not see the barrier lights until 0.2 miles range;
- to ensure the lookout was posted forward before the Woolwich Ferry;
- to appreciate that his order to "come slowly to port" was insufficiently precise bearing in mind the helmsman had little or no other information; and
- to appreciate the slowness of the turn.

These indicate he had overloaded himself. Furthermore nobody was in a position to monitor his actions: this was an unsatisfactory situation. The bridge was not manned with sufficient personnel.

Although the watchkeeping seaman was used as lookout for the first part of the river passage, he was sent below to carry out other duties when the vessel reached the end of Gravesend Reach. Notwithstanding the explicit instructions in both the master's and the company's standing orders that a lookout was to be posted, the master considered there was little value in having a designated lookout as the river had narrowed and the last of the fairway buoys had been passed. Even the presence of another vessel about half a mile ahead of *Sand Kite* was insufficient to persuade the master to keep the designated lookout. From that time, the mate, in addition to steering the vessel, acted as lookout, as best he could. When the vessel made her final approach to the barrier, the senior mate, who was a PEC holder for the river area to Angerstein's Wharf, was being used as helmsman and lookout

1 Roger G Green et al. (1991) *Human Factors for Pilots* (Avebury Technical 1991).

J.K. Pollard, E.D. Sussman, & M. Sterns, (1990). *Shipboard Crew Fatigue, Safety and Reduced Manning* (Cambridge, MA, U.S. Department of Transportation).

Thomas F. Sanquist (1996) *Fatigue and Alertness in Merchant Marine Personnel* (Groton, Conn., U.S. Coast Guard R & D Center).

which prevented him fully contributing to the navigation of the vessel. This was not the best use of his expertise and left the vessel exposed to any navigational errors or misjudgements that the master might have made.

Because they may have been out of practice, the master had no confidence in the general ability of the watchkeeping seamen to steer the vessel well. On vessels equipped with autopilots, many of which have tillers instead of wheels, hand steering is very seldom used. During the three weeks he had been master, he had discussed the seamen's steering ability with the mate and established, in common with other ships of his experience, that they were not generally used as helmsmen. He had intended to follow-up this discussion but had not done so prior to the accident. This was a serious shortcoming on *Sand Kite*. Where minimum numbers are employed to operate a vessel it is essential for each person to maintain the basic skills of his job. Had the master been able to rely on the steering skills of the seaman watchkeeper he would have had greater flexibility in organising his bridge team.

When the bridge watch changed about 50 minutes before the accident, both mates were on the bridge. This allowed the master momentary relief and a cup of tea. However the 0000 to 0600 watchkeeper, the registered PEC holder, was then allowed to go below although the vessel approached the critical stages of the passage through the barrier control zone to the berth upriver of the barrier. Given the continuing poor visibility, retention of the junior mate on the bridge to assist with navigation until the vessel was safely alongside would have been seamanlike and sensible. Bearing in mind the master's lack of confidence in the steering ability of the watchkeeping seaman and the company's requirements regarding a lookout (**Section 1.7.4**), the master should have sent the seaman forward at this stage, while retaining the junior mate as helmsman with the senior mate to assist and monitor the navigation of the vessel.

A designated lookout on the forecastle might have seen the barrier fog lights some 20 seconds before they would have been visible to an observer on the bridge and, possibly, in sufficient time to give a few seconds valuable warning. The company instructions regarding lookout are, in many respects, contradictory and do not appear to take account of operational requirements in poor visibility and the officer and crew numbers on *Sand Kite* (**Section 1.7.4**). However, it is clear that the company requirements are for a lookout to be placed forward when upriver of Woolwich Ferry in any condition of visibility. In fog it would have been prudent for the master to have posted a lookout forward much earlier.

The number of deck officers and deck crew on *Sand Kite* were the statutory minimum required. The reluctance of the master to use an off-duty mate, or the mates to insist on the seamen remaining on the bridge throughout their long watches, is understandable given the level of manning and the nature of their duties. Nonetheless, the master should have realised the circumstances on 27 October were anything but normal and used his available watchkeepers to best advantage for the safety of the vessel.

2.3 NAVIGATION

2.3.1 Speed and Separation in the River

Sand Kite made an average speed over the ground of about 11.7 knots between the reporting points at the Ovens and Margaret Ness. This was slightly faster than the other similarly sized vessels that were making passage that morning. At first the master maintained a distance of about half a mile from the vessel ahead which was initially *Thames*. Then both

Sand Kite and *Thames* overtook the small sand carrier *James Prior* between Crayford Ness and Fords.

Subsequently, at the invitation of *Thames*, *Sand Kite* overtook her off Fords so that *Thames* could slow prior to swinging for her berth at Becton. While *Sand Kite* was overtaking *Thames*, *City of Westminster* called on the VHF radio to invite *Sand Kite* to overtake her as well. Overtaking manoeuvres, either so that slower vessels do not impede the progress of others, or, because of ordering in the river so that vessels swinging for their berths do not impede those immediately following, are accepted standard practices. The fact that *Sand Kite*'s average speed was higher than other vessels may be accounted for in these manoeuvres.

As the vessels approached the barrier control zone, the master of *City of Westminster* reminded *Sand Kite* that his vessel would be berthing just down river of Angerstein's Wharf and invited *Sand Kite* to overtake *City of Westminster* "in Woolwich Reach or something – if that's what you'd like" (**Annex**). In good visibility it was a reasonable action to propose and execute except that overtaking between the barrier and Woolwich Ferry without specific permission from TBNC is contrary to bye-laws. *Sand Kite*'s master had previously sailed with the master of the *City of Westminster* in a subordinate capacity and held him in high regard. This, and the fact that he was new to his own command may have contributed to his decision to agree to the manoeuvre. It is apparent he had not planned on overtaking *City of Westminster* and only did so on the spur of the moment. *Sand Kite* overtook *City of Westminster* in Gallions Reach and this became, in retrospect, a contributory factor in the subsequent accident.

Each time *Sand Kite* overtook another vessel she increased her speed temporarily to ensure the manoeuvre could be accomplished as quickly as possible. As *Sand Kite* swung around Bull's Point into Woolwich Reach, she was making 13 knots over the ground, having just overtaken *City of Westminster*. She had 1.5 miles to go to the barrier and was proceeding with the flood tide.

The relatively high average speed and overtaking manoeuvres carried out by *Sand Kite* and others in the conditions of poor visibility reflects the confidence masters have in the ability of VTS to warn them of any unusual dangers. They knew, for instance, they would not meet any opposing traffic without warning. Meanwhile their radars would give them early warning of small boats and ferries.

Sand Kite's high speed on entering Woolwich Reach meant she had to slow rapidly before reaching the barrier. The master had intended to reduce speed to minimum manoeuvring speed by the time the barrier was reached. However, he was still slowing his vessel during the vital manoeuvring before the barrier and, by the time he reached it, the vessel was still making between 6 – 7 knots over the ground. The process of slowing down during the time when the master was attempting to line up for the final approach will have adversely affected the steering performance.

The overtaking manoeuvre in Gallions Reach meant that *Sand Kite* turned the corner into Woolwich Reach on the southern, or "wrong" side of the river. The master needed to bring the vessel up to the northern side before starting his final approach to the barrier.

Although the master's decision to overtake *City of Westminster* was based on an assessment that it was beneficial to approach the destination berths in the correct order, it was, in these particular circumstances, flawed. Overtaking another vessel so close to the barrier in

conditions of poor visibility placed more pressure on the small bridge team and increased the likelihood of mistakes being made.

In general, much of the overtaking that occurred on the flood tide during the early hours of 27 October was only necessary because of the relatively high speed and close separation of the vessels concerned. Only essential overtaking should take place in the river in fog especially within the barrier control zone. In the event of fog, traffic should slow down and allow greater separation between vessels. In the foggy conditions, it was unwise for the master of *Sand Kite* to overtake *City of Westminster* so close to the barrier; he should have slowed right down to allow greater separation.

2.3.2 Approach to the Barrier

Although the master had not previously been through the barrier in fog, he was confident in his ability to navigate safely and was, perhaps, subconsciously influenced by the fact that *City of Westminster*'s master was also continuing upriver. He planned his approach as if it was clear visibility, but using his radar to establish his position in the river and to check on the heading of the vessel. His plan to steer towards the "top third of the river" to line up with Echo Span as early as possible was sound. The master communicated his plan to the mate, who was then steering by hand, and conned *Sand Kite* to the northern side of Woolwich Reach. Echo Span was correctly identified on the radar and, at the appropriate moment, the master directed the mate to "come slowly to port". The mate did just that and *Sand Kite* turned to port far more slowly than the master had intended. His failure to give a precise conning order meant her turning circle was much larger than was necessary and she failed to steady on a course that would take her straight for the centre of Echo Span. She was too far to starboard of track. By the time the error was appreciated, it was too late to do anything about it (**Figure 5**).

During the final approach to the barrier the master had, apparently, remained convinced he would sight the fog lights in time to assist with lining up the vessel in the middle of the span. A vessel that had transited the barrier a little earlier had reported to Woolwich Radio she had first seen the lights at a range of 0.2 miles. Additionally *Arco Beck* had told *City of Westminster* that she too had first picked up the lights at 0.2 miles. Both these reports were transmitted on VHF Channel 14. It appears the master of *Sand Kite* was so preoccupied with the navigational situation he either did not hear them, or he heard them but did not appreciate their full significance.

In the event the master was surprised he could not see the lights at half a mile range (**Annex**). He was aware from his own observation that the general visibility was 0.2 miles, but it is apparent that he expected the high intensity lights to be visible at much greater range. Had he known at an earlier stage that he was unlikely to see the lights until he was 0.2 miles from the barrier he may have decided to anchor and await better visibility. Additionally, had he been following a pilotage passage plan he would have been constantly aware of emergency anchorage positions and be far better placed to make a considered decision.

Although expecting to see the lights, the master had implemented a rudimentary method of blind pilotage. Without anyone to assist him he had to rely totally on the radar for this purpose with little or no reference to the chart. He set his EBL on the required heading of 265° through the barrier, and ordered the helmsman to "come slowly to port" when the EBL was nearly touching the echo given by Echo Span's south pier. He knew from experience that this would bring the vessel into correct alignment, but appeared to forget that in clear visibility, a visual reference would influence the precise amount of wheel to be

applied. While the vessel turned in blind pilotage conditions, the master monitored the situation by watching the ship's heading marker on the radar closing with the EBL. This provided him with a rudimentary indication of rate of turn. Furthermore it is probable the master's attention was drawn to searching for the barrier lights in the critical moments as the vessel was turning.

The method of blind pilotage was flawed with too many uncertainties in its execution. He could not be certain of his exact position at the start of the turn and, without any parallel index plotting, had limited means of estimating progress in the manoeuvre. Furthermore, on approaching the barrier, he was still slowing the vessel, and therefore reducing the thrust of the propeller and the consequent effect of the rudder. The helm order he gave was imprecise, so he did not know how much helm had been applied. At the same time the actual speed over the ground meant *Sand Kite* was closing the barrier faster than he had planned.

The parallel indexing facility on the radar might have been used to good effect had the master planned ahead. In order to use parallel indexing for the barrier transit it would have been necessary to have foreseen the need and to have planned the approach in detail. The required parallel index lines could have been set up quickly when they were required.

The master expected to see the lights in time to navigate by eye through the barrier. By the time he realised this was not going to be possible, it was too late. The master's ability to conduct blind pilotage safely in *Sand Kite* is questionable. He had neither practised nor prepared for it, had left himself short of manpower and was trying to do too much himself. He was also going faster than he had planned. Effective blind pilotage needs constant practice. Ideally it should involve bridge resource management and simulator training. It should be routinely exercised in clear weather conditions so it can readily be introduced when required.

Transits of the barrier by vessels the size of *Sand Kite* are not barred due to lack of visibility and, in the opinion of the inspector, there is little reason to suggest such a restriction should exist. Vessels the size of *Sand Kite* should be able to safely navigate through the barrier if they are properly informed, equipped, manned and efficiently navigated. Owners, masters and the PLA as appropriate must ensure these criteria are met in all cases.

2.3.3 Sound Signals

Although *Sand Kite* was not making the sound signals prescribed by the Collision Regulations for a power driven vessel underway in restricted visibility, this is not uncommon on the river. The lack of sound signals was not a causal factor in this accident.

2.4 PILOTAGE AND THE ROLE OF THE PEC HOLDER

Although the PEC held by *Sand Kite*'s master was only valid to Northfleet, he had completed the six inbound and six outbound passages necessary to apply for an extension of this area to Angerstein's Wharf. There is no reason to think his application would have been refused had he done so. In general, although the 12 passages are construed as training, there is no requirement, either statutory or under local direction, for training to be given. Additionally, the inquiry established that a PEC for a vessel under 100m in length is generally awarded without a representative of the PLA meeting the applicant. While the PLA is not unique in this respect it is not the procedure adopted in a number of other comparable ports. The PLA assesses competence primarily by verification of an applicant's Certificate of Competency and other documentation.

Sometimes, when the registered PEC holder goes off-watch in mid-passage, the fact is not registered with PCL by vessels in the trade, including *Sand Kite*. One reason given is that PEC holders have no confidence in the PLA computer's ability to register the contribution of both PEC holders when a change is notified in mid-passage. This is confirmed by those responsible at the PLA who, at the time of the accident, believed their computer would only register, and remember, the last name to be entered.

A consequence of this failure to register a change would have been evident on this occasion when the entire pilotage "credit" would have been assigned on the computer to the 0000 to 0600 watchkeeper, the junior mate, whose actual contribution to the pilotage was the passage to seaward of Crayford Ness. At 0648, when the accident occurred the junior mate, the registered PEC holder, was asleep in his cabin.

Because of this apparent limitation in the system, the PLA has no accurate record of who actually pilots a vessel on any particular passage or section of a passage, and therefore has to rely for this information on the honesty of applicants for PEC renewal. This is unsatisfactory.

The events onboard *Sand Kite* that morning identified a second anomaly. Although a legitimate PEC holder, the mate, was on the bridge steering the vessel, his function as the helmsman meant he was not in a position to monitor the actions of the master conducting the pilotage. This was clearly unsatisfactory. In any pilotage situation it is essential that a second person monitors the actions of the person conning the vessel. Typically, where a licensed pilot is embarked, this is the role of the officer of the watch or the master.

One conclusion drawn from these situations is that it is possible for "pilotage credits" to be acquired by a person without his ever actually conducting an act of pilotage. Although the aspiring PEC holder might be "on watch" in accordance with the PLA regulations, this is not an assurance that he has received proper training, handled the ship on his own or conducted an act of blind pilotage.

Furthermore, the practice of the trade is for the master, who would normally be the holder of a PEC, to have pilotage responsibility for the vessel at all times when upriver of Gravesend. While this is entirely understandable and prudent, it raises the question as to whether other officers ever obtain sufficient experience of pilotage in the area of the Thames Barrier to warrant the issue, and subsequent renewal, of their PECs. In this context an applicant for renewal of a PEC must declare how many "acts of pilotage" he has undertaken in the previous year. It is possible the term is being loosely applied.

Under the Pilotage Act and under PLA pilotage directions only a bona fide master or first mate can be the registered PEC holder. This investigation has shown that on *Sand Kite*, both mates held valid PECs for the river. The junior of the two mates had obtained a PEC while serving as junior mate on *Sand Kite* and had renewed the PEC several times while serving in that category. The officer concerned holds a Class 2 Certificate of Competency and is clearly competent and experienced. Nevertheless, under one interpretation of the regulations, he should not have been able to obtain and hold a PEC. The practice where two mates and the master of a vessel hold PLA PECs is not confined to *Sand Kite*. Depending on the dredging ground and discharging berth, an aggregates dredger like *Sand Kite* can operate in and out of the Thames continually over long periods. Each pilotage from the outer limit of the pilotage area to discharging berth can take five hours or more, and turn-round times, loading and discharging, are short. If the second of the two mates is unable to be left in charge of the bridge anywhere in the PLA district, undue strain is

placed on the master and senior mate with a consequent effect on safety. However, this is not the only way the problem can be overcome, and alternative solutions are:

- for another deck officer to be employed on the vessel to relieve the master and senior mate of some non-pilotage duties; or

- for the vessel to employ a licensed pilot at times to ease the burden on the first mate and master.

South Coast Shipping Co Ltd has chosen, since the introduction of the PEC rules in 1988, to employ two mates on each of their vessels. Throughout their fleet, therefore, they have three officers on board who hold a PEC for areas covered by the vessel. In this case the master, having only recently joined the vessel, was not in possession of a PEC for the entire passage, although he had completed the number of trips to enable him to apply for such a certificate. Although registering a PEC for the junior of two mates might be considered as stretching the regulations it is not an unsafe practice where the officer concerned is appropriately qualified, trained and experienced. It should be noted, in this context, that the junior mate being the registered holder of the PEC for this passage, was not a direct contributory factor to the accident. This anomaly was recognised by the DETR during its recent review of the Pilotage Act 1987 and is being addressed.

Shortcomings in the operation of the regulations have come to light in the Inquiry. The PLA must have confidence that anyone awarded a PEC has conducted the requisite number of pilotage acts, that the person concerned is competent to pilot a vessel in good and bad visibility, and that the standards are maintained. The PLA should also have confidence that the registered PEC holder is actually performing the act of pilotage and not merely being an observer on the bridge or, more seriously, asleep in his cabin.

2.5 THE ROLE OF THAMES BARRIER NAVIGATION CENTRE (TBNC)

The stated functions of the TBNC include a requirement to "*control traffic in the barrier control zone*" and to "*monitor and regulate traffic to ensure compliance with all regulations*". The Inquiry sought to establish how these functions were being executed on the morning of 27 October.

A qualified master mariner, the marine officer, is always on duty at the TBNC. On the morning of 27 October the marine officer left the operations room for a rest at 0230 leaving the VTS operator in charge in the operations room. The visibility at the time was good. At 0400 the VTS operator called the marine officer to inform him of the reduction in visibility. The marine officer decided to remain in the rest room as there was no traffic underway in the vicinity and the VTS operator was happy with the situation. The marine officer was called at 0600. He arrived in the operations room at about 0615, at which time the first of the morning's traffic, a small sand carrier, was passing through the barrier. *Arco Beck* was just entering the barrier control zone and *Sand Kite* was just shaping to overtake *Thames* off Fords at Dagenham.

The appointment of master mariners to the position of marine officer, and the practice of a marine officer always forming part of the duty watch, suggests an expectation that they should be able to use their experience and training to anticipate the needs of those using the river and give such advice or directives as appropriate to ensure safe passage. Additionally they should have the ability to judge the actions of river users against the

appropriate local, national and international regulations and guidance to ensure compliance. Despite the indication that the proposed overtaking manoeuvre between *Sand Kite* and *City of Westminster* might contravene a local restriction, the marine officer saw no reason to intervene or give advice. The only directive that came from the TBNC arose when the designated span was changed, by the VTS operator, from Foxtrot to Echo at the request of a user.

In the event, the local restriction on overtaking in the area between Woolwich Ferry and Island Jetty, the centre section of the barrier control zone, was observed by all ships. However, this restriction does not address the subsequent position and speed of vessels on completion of an overtaking manoeuvre made just outside of the area.

There is no speed limit for vessels in the reaches downriver of the barrier. Nonetheless it is clearly stated that speed should at all times be safe and commensurate with local circumstances and conditions. The available guidance indicates a maximum speed of 10 knots through the water is appropriate in reaches above Gravesend in order to reduce the effects of wash and draw-off. Most inbound vessels were making just less than this speed in the foggy conditions and greater speeds were being reached occasionally while overtaking.

Sand Kite's final more northerly track than usual was noted by the VTS operator who brought it to the attention of the marine officer. However, it did not raise undue concern because many vessels choose a similar approach to allow for the slight cross current. The equipment at TBNC does not have sufficiently good resolution to allow for navigational advice to be given in a close quarters situation and events tend to develop too quickly in the latter stages of a barrier transit for it to be feasible. Remote pilotage is not a function of TBNC VTS staff.

The speed and ordering of vessels to ensure no conflict when they arrive off their destination berths is generally left to the vessels themselves to arrange. This is an important safety matter. The Inspector believes that, as such, it needs early consideration especially in foggy conditions. The PLA is in possession, through its control centres, of far more information than the individual vessels concerned. In order to fulfil its functions as a VTS, as highlighted earlier in the report, the TBNC should be more proactive in this respect both at an early stage and as situations develop.

The following conclusions are drawn:

- The concept of a barrier control zone is endorsed by the Inquiry. Notwithstanding the fact that *Sand Kite* and *City of Westminster* had completed the overtaking manoeuvre before reaching the Woolwich Ferry, in accordance with PLA notices to mariners, an extension of the restricted zone and statement of criteria to be met by overtaking vessels would reduce further any risk to the barrier should failures similar to those which occurred in *Sand Kite* ever be repeated.

- In the foggy conditions it was imprudent for the marine officer to remain in the rest room once the first vessels had passed Crayford Ness and entered the area under his control at about 0530. Had he been monitoring the developing situation, he would have been better placed to offer advice, guidance and directions.

- The separation between vessels approaching the barrier should have been greater. As it was, *City of Westminster* passed through Echo Span less than three minutes after *Sand Kite* had collided with Pier 5; the distance between the two vessels had been between

0.2 and 0.3 miles. It was fortuitous that *Sand Kite* had managed to move quickly astern and clear of Echo Span by that time.

- The TBNC in fulfilling their functions should have been more proactive at an early stage in respect of the sequencing and speed of vessels.

2.6 THE THAMES BARRIER – NAVIGATION AIDS

It has been already been stated that a properly informed, equipped, manned and efficiently navigated vessel of the size of *Sand Kite* should be able to navigate safely through the barrier in fog. Nevertheless, any assistance that can be given to the master or pilot in terms of additional navigational aids on the barrier to help identify the designated span would be beneficial.

The fog lights fitted to each of the piers of the barrier consist of an array of lamps made in the USA for use on locomotives. These lamps are used on other marine applications in the UK and have been found to be effective in certain conditions. Due to the alignment of the barrier and its position upstream of a slight bow in the river, fog lights need to be visible at a range of at least 0.35 miles to be of greatest benefit. This range coincides with the position where an inbound vessel begins to turn to line up with Echo Span. At this range, in thick fog, the existing lights are not visible and are only of benefit in the final stages of a transit. It is questionable whether any conventional fog lights could penetrate 0.35 miles in the thickest conditions. This is a fact not fully appreciated by mariners. The master of *Sand Kite* was expecting to see the fog light at up to 0.5 miles despite knowing that the general horizontal visibility was far less than that.

A contributory cause of the accident was *Sand Kite*'s master's ignorance of the true visibility at the barrier. The regular half hourly broadcasts issued by Woolwich Radio at TBNC that morning included a general statement about fog in all reaches. All vessels, including *Sand Kite*, making passage upriver experienced patchy fog. It would be helpful if specific information about the current range of visibility of the high intensity lights was communicated to vessels as they entered the barrier control zone. For such relevant and important information it is not sufficient to rely on masters overhearing other vessels' reports.

Since the accident, the PLA has experimented with a racon beacon system designed to be fitted to the piers either side of the navigational spans. The beacons will be activated together with the appropriate fog lights. When activated, the system gives an unambiguous indication of the designated span on the radars of approaching vessels. During the experiment, the instrument was temporarily fitted to the barrier and trialed by PLA vessels and, subsequently, commercial vessels using the port. The response has been unanimously favourable. Although the master of *Sand Kite* correctly identified the designated span from his own resources, evidence from the trial indicates that the racon system is likely to further aid the conduct of blind pilotage.

SECTION 3
Conclusions

3.1 FINDINGS

1. *Sand Kite* collided with Pier 5 of the Thames Barrier at 0648 on 27 October 1997. [1.2]

2. The visibility of the high intensity lights on the barrier was about 0.2 miles in thick fog [1.2]

3. The master and senior mate were the only people on the bridge of *Sand Kite* at the time of the accident. [1.2]

4. The radar's gyro heading was checked against the main compass and found to be accurate on the morning of the accident. [1.6.2]

5. At the time of the accident the vessel was fully certificated in accordance with national and international regulations. [1.6.3]

6. *Sand Kite*'s deck manning was in accordance with the requirements of her minimum safe manning certificate. [1.7.1]

7. The master was reluctant to make use of the off-duty mate due to the long watch periods and other duties. [1.7.2, 2.2]

8. The mates were reluctant to use the watchkeeping seamen as lookouts when they thought it to be non-essential. [1.7.2, 2.2]

9. Both master and mate on the bridge of *Sand Kite* were sufficiently rested prior to the accident. [1.7.6]

10. Neither alcohol nor drugs were contributory factors. [1.7.7]

11. *Sand Kite* came to rest in Foxtrot Span on top of the barrier gate which was housed in its recess on the river bed. [1.4.3]

12. Foxtrot Span was out of commission for a period of five days during which time *Sand Kite* was refloated and salvaged. [1.4.3]

13. The barrier's navigation and fog lights were operating correctly and at highest intensity at the time of the accident. [1.4.4, 2.1]

14. At the time of the accident, the master, who did not hold a current PEC for the area of the barrier, had control of the navigation on *Sand Kite*. The senior mate, who held a current PEC for the area of the barrier, was steering the vessel. [1.5.1, 2.4]

15. The PEC holder, reported to the PLA as having conduct of the vessel, was serving as the junior of two mates, and had been relieved on the bridge and was asleep in his cabin at the time of the accident. [1.5.1]

16. There was some uncertainty among both PLA staff and PEC holders as to how the PLA computer recorded changes to the registered PEC holder when notified mid-passage. Generally people considered that the computer only registered the last name put forward. For this reason changes were often not reported to the PLA. [1.5.1, 2.4]

17. The machinery and instrumentation on *Sand Kite* was functioning correctly. [2.1]

18. *Sand Kite* was following the normal practices of the river in respect of her speed and overtaking manoeuvres. [2.1]

19. The team management, number of personnel and allocation of responsibilities on the bridge was inadequate for the prevailing conditions. [2.2]

20. The master did not have confidence in the seamen's ability to steer as they were rarely used as helmsmen and therefore out of practice. This reduced the flexibility he had to organise his bridge team. [2.2]

21. Despite just entering the more difficult stages of the river passage the junior mate was allowed to leave the bridge soon after the end of his watch at 0615. [2.2]

22. No lookout was posted on the forecastle contrary to South Coast Shipping Co Ltd's Standing Instructions. Had one been, he would have been able to see the barrier's fog lights about 20 seconds earlier than the people on the bridge. [2.2]

23. As *Sand Kite* entered Woolwich Reach, 1.5 miles from the barrier, she was making 13 knots over the ground and positioned on the southern side of the river having just overtaken *City of Westminster*. [2.3.1]

24. The master's decision to overtake *City of Westminster* was apparently taken on the spur of the moment when he was invited to consider it by *City of Westminster*'s master. His decision to agree the manoeuvre may have been influenced by the fact that he held *City of Westminster*'s master in high regard. [2.3.1]

25. It was unwise of the master to overtake *City of Westminster* so close to the barrier in the foggy conditions. [2.3.1]

26. The master was still slowing his vessel to minimum manoeuvring speed while manoeuvring to line up for the barrier. At the moment of collision the vessel was still making between 6–7 knots over the ground. [2.3.1]

27. The master had not previously been through the barrier in fog. [2.3.2]

28. The final turn into alignment with the barrier was incorrectly executed. It was not properly controlled or monitored and, by the time the master appreciated he was displaced too far to the north of the planned track through Echo Span, it was too late to correct the error. [2.3.2]

29. The master had been expecting to pick up the fog lights from the barrier in time to assist in getting the correct alignment and may not have given his full attention to navigation by radar. [2.3.2]

30. The master did not register two VHF radio reports, one intership and one between ship and TBNC, indicating the visibility of the high intensity fog lights, which were made prior to his own approach to the barrier. [2.3.2]

31. The master was not following a developed pilotage passage plan. Had he been so, he would have been better placed to choose to anchor to await better conditions. [2.3.2]

32. The blind pilotage technique operated by the master was rudimentary. [2.3.2]

33. Parallel indexing on the radar was not used. [2.3.2]

34. The master left himself short of manpower and unprepared to conduct blind pilotage right up to and through the barrier. [2.3.2]

35. The PLA generally awards a PEC, in respect of a vessel below 100m in length, without anybody from the authority meeting the candidate. They rely entirely on the applicant's certificate of competency as proof of overall navigational ability including the practice of blind pilotage techniques. This is not the practice adopted by many other ports. [2.4]

36. The legitimate PEC holder who was on the bridge of *Sand Kite* was not in a position to monitor the navigation. [2.4]

37. There are no PLA rules that state a PEC holder must pilot the vessel or that an applicant for a PEC must receive pilotage practice or training. [2.4]

38. That both the mates on *Sand Kite* held and used their PEC's was not in itself an unsafe practice. [2.4]

39. In the prevailing foggy conditions on 27 October, it was imprudent for the marine officer, who was on duty at the TBNC, to remain in the rest room once inbound river traffic had passed Crayford Ness. [2.5]

40. The marine officer did not advise against *Sand Kite* overtaking *City of Westminster* within the barrier control zone. [2.5]

41. *City of Westminster* passed through Echo Span less than three minutes after *Sand Kite* had collided with Pier 5. The distance between the two vessels was about 0.2 to 0.3 miles. [2.5]

42. In order to fulfil its stated functions the TBNC should have been more proactive in the ordering and speed of vessels. [2.5]

43. Vessels of the size of *Sand Kite* should be able to navigate safely through the barrier in fog, provided they are properly informed, equipped, manned and navigated. [2.5]

44. TBNC gave warnings of "fog in all reaches" in their routine VHF broadcasts prior to the accident. [2.5]

45. TBNC did not inform traffic in the barrier control zone about the latest estimate of the visibility of the fog lights. [2.5]

3.2 CAUSES

The Immediate Cause

The accident was caused, first, by the failure of the master of *Sand Kite* to execute an accurate turn on to a course to ensure safe passage through the barrier and, second, his failure to detect his vessel was too far off track until it was too late to take corrective action.

Contributory factors and Underlying Causes

1. The presence of dense fog on the River Thames, especially in Woolwich Reach, as *Sand Kite* approached the Thames Barrier.

2. The failure to man the bridge with sufficient personnel.

3. The failure to post a lookout forward.

4. The decision to overtake *City of Westminster* within the barrier control zone which resulted in *Sand Kite* still adjusting her speed as she approached the barrier.

5. The master's workload level was too high causing him to miss or misinterpret some important information.

6. The lack of steering practice by seamen on board *Sand Kite*.

7. The master's helm order "come slowly to port" was insufficiently precise to ensure an accurate approach.

8. The failure of the TBNC to foresee the developing situation and advise accordingly.

SECTION 4
Recommendations

During, and arising from, the *Sand Kite* Inquiry MAIB issued Safety Bulletin 3/98 on 16 January 1998 which included the following interim recommendations:

4.1 THE PORT OF LONDON AUTHORITY is recommended to:

1. *Amend its procedures for issuing and revalidating PECs by:*

   — introducing a system whereby the practical competence of applicants for, and existing holders of, a PEC covering the area of the Thames Barrier can be checked periodically to ensure levels of competency are held and maintained. Such checks should assess a PEC holder's ability to conduct acts of blind pilotage;

   — insisting that all applicants for renewal of a PEC must have had full responsibility for the pilotage of a vessel for the requisite number of passages -- a means of verifying this must be introduced;

2. *Remind masters of the need to inform the PLA whenever the PEC holder having pilotage responsibility is changed during a passage;*

3. *Ensure that all such changes are properly recorded.*

The following additional recommendations are made at the conclusion of the investigation.

4.2 SOUTH COAST SHIPPING CO LTD is recommended to:

4. Ensure that the lessons learned from this accident are put into practice on all its vessels and, to this end, consider sending its senior officers on bridge resource management simulator training including refresher instruction on radar navigation techniques;

5. Rationalise its instructions on watchkeeping and lookout, removing contradictory statements and taking into account the size of crew, visibility from the wheelhouse, state of visibility and other operational requirements of the particular vessel.

4.3 THE PORT OF LONDON AUTHORITY is further recommended to:

6. Consider amendments to general directions in respect of the conduct of vessels in the barrier control zone in conditions of reduced visibility which would extend the restricted overtaking zone and lay down conditions to be met by vessels overtaking;

7. Encourage marine officers to be more proactive in their approach to river safety, by pre-empting developing situations and giving timely advice or directions;

8. Investigate the feasibility of fitting visibility sensing equipment at the barrier to enable specific real-time information to be passed to vessels intending to navigate through the barrier;

9. Pursue the experiments currently being conducted, on the suitability of racon instrumentation at the barrier to assist masters and pilots to positively and easily identify the correct allocated span.

4.4 THE DETR is recommended to:

10. Review the effect of the constraints currently imposed on officers, other than masters and bona fide first mates, from holding PECs.

SECTION 5
Actions taken

5.1 PILOTAGE DIRECTION NUMBER FIVE

Prior to the accident, the PLA had conducted a review of its pilotage regime and was consulting publicly on a draft pilotage direction. As a result Pilotage Direction 5, which replaces all previous directions, was published in January 1998 and came into force on 17 August 1998. The new direction includes the following provisions which are relevant to this accident:

- the PLA routinely exercises its right to interview PEC applicants for vessels under 100m in length overall;

- applicants for a PEC may only count as qualifying trips those trips undertaken in the position of bona fide master or first mate and must have been on the navigating bridge of the vessel during the qualifying trips; this fact must be attested by the pilot, or PEC holder in charge, signing the applicant's tripping log;

- the PEC holder is required to be on the bridge, or other location from which the vessel is being navigated, and to have *conduct* of the vessel;

- when one PEC holder is relieved by another PEC holder during a passage within the London Pilotage District, Port Control London must be informed by VHF and the new PEC number reported;

- it is recommended that holders of PECs navigating within the Port of London Pilotage District arrange their watch changes to coincide with the passage of the vessel from one pilotage exemption area to another. The reporting of such changes will result in complete areas being credited to the record of the holder of the certificate against renewal of that certificate. Part areas will not receive credits. In practice this will involve changing watch, and reporting that change to Port Control London, either at Sea Reach 1 buoy or when passing Gravesend Pilot Station.

ANNEX

VHF channel 14 recording – *Sand Kite* – Thames Barrier incident

27 OCTOBER 1997

Time	From	To	Message
0557.50	*Brenda Prior*	Woolwich Radio **(TBNC)**	Good morning, Margaret Ness.
	Woolwich Radio	*Brenda Prior*	Foxtrot Span. ***[Voice of VTS operator]***
	Brenda Prior		Thank you.
0558.			
0559.			
0600.			
0601.30	*James Prior*	Woolwich	Good morning we're at Crayford Ness inwards, over.
	Woolwich Radio	*James Prior*	Good morning, Crayford Ness inwards, thank you.
0602.20	*Thames*	Woolwich Radio	Good morning, we're Crayford Ness inwards for Northern Outfall Becton.
	Woolwich Radio	*Thames*	Good morning, Crayford Ness inwards for Northern Outfall Becton thank you.
0603.40	*Thames*	*James Prior*	Thanks Skip.
	Thames		You're welcome. ***[Thames overtakes James Prior]***
0604.40	Woolwich Radio	*Twinstar* **[Small ferry operating across the river at Dagenham]**	Good morning.
	Twinstar		Yes, good morning to you, Woolwich. Obviously you know it's foggy down here so we're starting our runs now.
0605.	Woolwich Radio	*Twinstar*	Did you say you were just starting your service over?
	Twinstar		Yes, Woolwich, just starting our service now.
	Woolwich Radio		Roger, you've got the *Arco Beck* just approaching Fords inward bound, over.
	Twinstar		Roger, Woolwich, thank you.
0606.10	*Sand Kite*	Woolwich Radio	Crayford Ness inwards, over.
	Woolwich Radio	*Sand Kite*	Crayford Ness inward, thank you, good morning.
	Sand Kite		Good morning to you.
.40	*Arco Beck*	Woolwich Radio	Fords inwards.
	Woolwich Radio	*Arco Beck*	Fords inwards, thank you.
0606.50	*James Prior*	*Sand Kite*	Take it that's you behind us. I've eased ***[I'll ease]*** down and let you get round before Coldharbour.
	Sand Kite		OK thanks a lot, *James Prior*. I've just eased up myself. I'll put her back up, cheers.
0607.20	*Thames*	*Sand Kite*	I've pulled back again because I'm catching up the *City of Westminster*.
	Sand Kite		Yes, I see that. Thanks a lot, *Thames*.

Time	From	To	Message
0608.30	*City of Westminster*	Woolwich Radio	Just over one cable passing Erith. ***[visibility]***
.50	*Arco Beck*	*City of Westminster*	Yes, I've just passed Fords, it's picked up to about three cables now.
	City of Westminster		Good, thanks for that.
0609.	*Sand Kite*	*James Prior*	Many thanks. ***[Sand Kite having passed James Prior]***
	James Prior		Yes, you're welcome, Skip.
.10	*City of Westminster*	*Arco Beck*	Where are you going?
	Arco Beck		Up to Blackwall.
	City of Westminster		Up to Blackwall, thanks.
	Thames	*Sand Kite*	
	Sand Kite	*Thames*	
.30	*Thames*		Would you like to come by when we get up towards Fords, then I won't have to swing ahead of you at Becton, over.
	Sand Kite		That'll make life a lot easier (mate), yes, cheers.
	Thames		OK, as soon as we get clear of Jenningtree I'll drop her right back and keep up to the north side for you then.
.40	*Sand Kite*		All understood, thanks.
.50	*Brenda Prior*	Woolwich Radio	
	Woolwich Radio	*Brenda Prior*	
	Brenda Prior		May we have Echo Span or is that in defence?
0610.	Woolwich Radio		Negative, I'll put Echo Span on for you.
	Brenda Prior		OK, lovely jubbly, have you got the high density lights there or not?
	Woolwich Radio		I'll put them on for you.
	Brenda Prior		Thank you.
.40	Woolwich Radio	*Brenda Prior*	On for you now.
.50	*Brenda Prior*		Thank you very much.
0611.			
0612.30	*Scoundrel*	Woolwich Radio	Good morning, leaving Warspite Roads – light tug inward bound for West India Dock.
.40	Woolwich Radio	*Scoundrel*	Roger, Echo Span please.
.50	*Scoundrel*		Echo Span. Thank you.
	Brenda Prior	Woolwich Radio	Picking up the lights at two cables.
	Woolwich Radio	*Brenda Prior*	Roger, yes, I can just see them myself now, Roger.
0613.30	*Twinstar*	Woolwich Radio	
	Woolwich Radio	*Twinstar*	
.40	*Twinstar*		Going north to south, Woolwich, them other two are not round Jenningtree yet, are they?
	Woolwich Radio		The *Thames* is just at Jenningtree now, over.
.50	*Twinstar*		Roger, we'll be across before they get here. Thank you.
	Woolwich Radio		Roger.
0614.	*City of Westminster*	*Twinstar*	We are round Jenningtree.
	Twinstar		You are round Jenningtree.
	City of Westminster		That's affirmative.

Time	From	To	Message
	Twinstar		Roger, we can't see you on the radar so we'll shoot straight across at the Sewerage Works before you.
.30	*City of Westminster*	*Twinstar*	See you crossing there you are well ahead of us.
	Twinstar		Roger, Skip.
0615.	Woolwich Radio	All Ships	With the river broadcast for 0615. Navigation information – there is fog in all reaches. At the Thames Barrier spans available, Foxtrot in and Charlie out. Isophase lights inoperative at Charing Cross Bridge and arches 2 and 4 closed to navigation at Fulham Rail Bridge. Tidal information: Silvertown 2.6m and Tower Pier 2.2m. Both these readings are 0.3m below prediction. Reading at Richmond is 0.2m below chart datum. That's the end of the river broadcast. Woolwich Radio out.
0615.50	*Thames*	*Sand Kite*	I'm pulling back all the time now and I am going to be holding her steady very shortly?
0616.	*Sand Kite*		Roger, all received I'll keep to the south of you, *Thames*. Thanks a lot.
.30	*City of Westminster*	Woolwich Radio	Fords inwards.
	Woolwich Radio	*City of Westminster*	At Fords inwards. Thank you.
0617.			
0618.	*City of Westminster*	Woolwich Radio	Amies Dagenham and there's been a bit of a clearance here.
	Woolwich Radio		Roger, understood. Many thanks.
.30	*Arco Beck*	Woolwich Radio	Margaret Ness inwards. Permission for barrier please.
	Woolwich Radio	*Arco Beck*	Roger. Echo Span please.
.40	*Arco Beck*		Echo Span, thank you – put lights on, please.
	Woolwich Radio		Yes, full lights are on.
0619.			
.30	*Thames*	Woolwich Radio	Fords inwards.
	Woolwich Radio	*Thames*	Fords inwards.
.50	*Sand Kite*	Woolwich Radio	Fords inwards.
	Woolwich Radio	*Sand Kite*	Fords inwards.
	City of Westminster	*Sand Kite*	
	Sand Kite	*City of Westminster*	
	City of Westminster		Yuh, you probably know that we're going to Murphys and you're Angersteins – if you want to get close to me I'll try and get you by in Woolwich Reach or something – if that's what you'd like.
0620.	*Sand Kite*		Yes. I'll hang close on your stern then, Mike.
.50	*Sand Kite*	*Thames*	Thanks for your help. ***[Having overtaken]***
0621.	*Thames*		You're welcome, safe trip.
0622.	*Twinstar*	Woolwich Radio	Going south to north we'll hang back for that one that's coming up past the power station now. ***[voice of marine officer now on radio at TBNC]***
	Woolwich Radio	*Twinstar*	*Twinstar*, south to north once the vessels have cleared from the power station. Roger – thank you.
	Twinstar		Roger.
0622.20	*Brenda Prior*	Woolwich Radio	Blackwall Point inwards.
	Woolwich Radio	*Brenda Prior*	Blackwall Point inwards.
	Brenda Prior		Bugsby's is clear. **[visibility].**

Time	From	To	Message
.30	Woolwich Radio		Bugsby's is clear, thank you very much for that.
0623.	*Twinstar*		Vessel inward bound Fords – Fords ferry.
	James Prior		Yes, *James Prior*, Over.
	Twinstar		All yours *James Prior* – we'll come under your stern.
	James Prior		OK, cheers.
.10			
0624.			
.20	*James Prior*	Woolwich Radio	We're Fords inwards. Out.
0625.	Woolwich Radio	*James Prior*	Fords inwards. Thank you.
0626.			
0627	*City of Westminster*	*Sand Kite*	I am easing back now and down to 9 knots.
.10	*Sand Kite*		Full in view – just easing back. Thanks, Mike.
0628.			
0629.10	*City of Westminster*	Woolwich Radio	Margaret Ness. Permission for the barrier, please.
	Woolwich Radio	*City of Westminster*	Margaret Ness inwards. Roger, Sir. Echo Span, please.
	City of Westminster		Echo Span. Thank you.
.30	*Thames*	Woolwich Radio	We're just approaching Barking Point inwards. We'll soon be crossing south to Margaret Ness prior to swinging 4 and 1 for North Outfall, Becton.
.40	Woolwich Radio	*Thames*	We are not aware of anything outward bound in Gallions.
	Thames		Roger, thank you.
	Woolwich Radio	All ships	Navigation information. The *Thames* passing Barking Point inwards, the vessel will be crossing to the south of the fairway at Margaret Ness before making fast at the Northern Outfall at Becton.
0630.			
.10	*Twinstar*	Woolwich Radio	North to south.
	Woolwich Radio	*Twinstar*	North to south, Roger. We are not aware of any traffic in or out.
.20	*Twinstar*		Roger, Woolwich.
.30			
0631.30	*Energy*	Woolwich Radio	
	Woolwich Radio	*Energy*	Good morning.
	Energy	Woolwich Radio	Good morning. Just leaving barrier Garden inward bound for Delta, permission please?
	Woolwich Radio		Roger. Echo Span please.
.40	*Energy*		Echo, thank you. Got the position of the *(Arco) Beck* at the moment, please?
	Woolwich Radio		Just approaching the ferry inwards.
.50			
0632.			
.20	*Sand Kite*	Woolwich Radio	Margaret Ness entrance and, er, permission for the barrier please?
	Woolwich Radio	*Sand Kite*	Echo Span, please.
	Sand Kite		Echo Span, thanks.
.30	*City of Westminster*	*Sand Kite*	Do you want to go by now? I'm pulling her right back for you.

Time	From	To	Message
	Sand Kite		Okay, Mike, thanks for that, we will.
.40			
0633.			
0634.			
0635.			
0636.			
0637.	*Twinstar*	Woolwich Radio	North to s … e … south to north.
	Woolwich Radio	*Twinstar*	South to north, thank you.
0638.			
0639.	*Sand Kite*	*City of Westminster*	Just easing back now.
.40	*Warrior*	Woolwich Radio	Morning to you. We're just leaving (Warspite for Barrier Garden Pier).
	Woolwich Radio		Roger. Leaving Warspite for Barrier Garden Pier.
0640.	*Arco Beck*	Woolwich Radio	All clear of the barrier.
	City of Westminster	*Arco Beck*	***(visibility enquiry)***
	Arco Beck		Yeah, I picked the high intensity lights up at two cables.
	City of Westminster		Two cables, that's good. Thanks for that.
.40	*James Prior*	Woolwich Radio	Margaret Ness inwards over.
	Woolwich Radio	*James Prior*	Echo Span, please.
	James Prior		Echo, thank you.
0641.			
.40	*Twinstar*	Woolwich Radio	North to south.
	Woolwich Radio	*Twinstar*	North to south.
.50	*Jim Higgs*		Woolwich Radio
0642.	Woolwich Radio	*Jim Higgs*	Good morning.
	Jim Higgs	Woolwich Radio	Good morning. We're underway at Coldharbour manoeuvring with craft over.
	Woolwich Radio		Roger, *Jim Higgs* underway at Coldharbour manoeuvring with craft.
.10	*Thames*	Woolwich Radio	We are now secure at the northern outfall. I've got no sailing time at the moment for anything, over.
.20	Woolwich Radio	*Thames*	All secure understood, good morning to you.
.30	*Thames*		Thank you, Woolwich. Good morning.
.40			
0643.			
0644.10	*Sand Kite*	Woolwich Radio	Just 5 cables to the barrier, er, can we have the fog lights on please?
.20	Woolwich Radio		Er – they are on, I'm afraid.
	Sand Kite		Oh dear, right, thanks.
.30			

Time	From	To	Message
.50	Woolwich Radio		All ships this is the Woolwich Radio with the river broadcast for 0645. Navigation information: visibility, reports of dense fog in all reaches; at the Thames Barrier spans available Echo in and Charlie out; Isophase lights are inoperative at Charing Cross Bridge and arches 2 and 4 are closed to navigation at Fulham Railway Bridge. Tidal information: Silvertown 3.2, Tower Pier 2.7. Readings are 0.3 below prediction. The reading at Richmond is 0.3 below chart datum. That is the end of the broadcast. Woolwich Radio out.
0645.30	*Energy*	*Arco Beck*	Blackwall Point inwards. We've got about three cables and clearing.
	Arco Beck		Thanks very much, *Energy*.
.40			
0646.			
0647.			
.40	Woolwich Radio	*Sand Kite*	Do you have the span visible now?
.50	*Sand Kite*	Woolwich Radio	Yes.
	Woolwich Radio		Roger.
0648.	*Twinstar*	Woolwich Radio	South to north.
	Woolwich Radio	*Twinstar*	South to north. Thank you.
.10	*Arco Beck*	Woolwich Radio	Just approaching Blackwall point inwards. Round the point I will be swinging four and two for Delta Wharf and its limited to about three or four cables here now.
.20	Woolwich Radio	*Arco Beck*	Roger, that's understood. Approaching Blackwall inward bound, shortly be manoeuvring for Delta Wharf, thank you.
.30			
0649.			
.40	Woolwich Radio	*Sand Kite*	
	Sand Kite	Woolwich Radio	
	Woolwich Radio		Your situation now, sir?
.50	*Sand Kite*		We are on the, erm, er, Golf, er, Span, trying to get through Golf Span, over.
0650.	Woolwich Radio	*Sand Kite*	That's understood.
0650.	Woolwich Radio	*City of Westminster*	Are you aware of that?
	City of Westminster		Yeah, and, er, just coming through Echo Span.
.10	Woolwich Radio		Yeah, roger, thank you.
.20	*Sand Kite*	Woolwich Radio	Yes, we're holed, looks like we're ...
.40	*Sand Kite*	Woolwich Radio	"Mayday", we're holed forward – over on the Golf Span.
.50	Woolwich Radio	*Sand Kite*	Roger.
0651.	Woolwich Radio	*James Prior*	
	James Prior		Yeah, copied that, I'll take a turn and stem the tide and wait further instructions.
	Woolwich Radio		Roger.
.10			All ships, all ships, Woolwich Radio.
.20			Navigation information, *Sand Kite* presently athwart Golf and Foxtrot Spans on the lower side of the barrier, the vessels involved, all vessels in the area pass with extreme caution. Woolwich out.

APPENDIX
Alternative Text

Regulations 9(4) and 9(6) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 1994 provide that any person whose reputation is likely to be adversely affected by the Report shall have the opportunity to comment on that part of the Report before it is submitted to the Secretary of State. If, following representations, there are passages in the Report which remain in issue and are critical of the person, alternative text can be provided by the person for the part which is in issue. Such alternative text must be included with the Report as an appendix.

A number of persons, companies and organisations have exercised their rights in this respect. The alternative texts, which have been incorporated into the relevant numbered paragraphs from the Report, are given following, together with the person, company or organisation who provided the text.

South Coast Shipping Co Ltd

1.7.4 Company Instructions on Watchkeeping and Lookout

"The following instructions *which were approved by the Deputy Chief Inspector and two of his inspectors in November of 1989* have been extracted from South Coast Shipping Co Ltd's Company Operations Book, are particularly relevant to this accident."

MAIB Footnote

South Coast Shipping Co Ltd sent a copy of revised standing orders to MAIB for comment following the report into the Marchioness/Bowbelle collision. Several observations were made by inspectors which were passed to South Coast Shipping Co Ltd.

2.6 THE THAMES BARRIER – NAVIGATION AIDS

(3) "A contributory cause of the accident was *Sand Kite*'s master's ignorance of the true visibility at the barrier. The regular half hourly broadcasts issued by Woolwich Radio at TBNC that morning included a general statement about fog in all reaches. All vessels, including *Sand Kite*, making passage upriver experienced patchy fog. It would be helpful if specific information about the current range of visibility of the high intensity lights was communicated to vessels as they entered the barrier control zone. For such relevant and important information it is not sufficient to rely on masters overhearing other vessels' reports. *In this case a broadcast at 6.16 or 6.39 by the Thames Barrier Navigation Centre over Woolwich Radio would have alerted the master to the restricted range of visibility and may have enabled him to take some evasive action.*"

3.1 FINDINGS

.45 "TBNC did not inform traffic in the barrier control zone about the latest estimate of the visibility of the fog lights *either at 6.15 or 6.39*. [2.5]"

3.2 CAUSES

Contributory Factors and Underlying Causes

8. "The failure of the TBNC to foresee the developing situation and advise accordingly *and in particular the failure to give specific warnings on reduced visibility at either 6.15 or 6.39.*"

Port of London Authority

3.2 CAUSES

Contributory Factors and Underlying Causes

8. "The failure of the TBNC to *recognise* the developing situation *early enough to advise vessels not to close, and hence avoid the need to overtake before reaching the barrier.*"

Environment Agency

Synopsis

"During the early morning of 27 October 1997, *Sand Kite*, a trailing suction dredger of 98m in length, was inbound in the River Thames and making for a berth about half a mile upriver of the Thames Barrier. She was loaded with approximately 3,300 tonne of sand and gravel. At 0648, and while trying to navigate through one of the spans of the Thames Flood Barrier in thick fog, she collided with one of the barrier's concrete piers. Although she started to take water immediately, she was moved astern and clear of the designated navigable span before coming ahead in an attempt to pass through an adjacent span. As she did so her bow sank and came to rest on the river bed on top of the housed barrier gate. *This was a serious incident which put one of the main gates of the Thames Barrier out of commission until Sand Kite and the majority of her lost cargo was removed from gate Foxtrot. This was a total of twelve days. Due to the quality of its design the Thames Barrier is able to give good and adequate flood protection to London with only nine of her ten gates closed. However, with gate Foxtrot disabled, the safety margin had gone. If during that period there had been a failure, for whatever reason, of any other gate, there would have been a risk of serious flooding.*"

Master of *Sand Kite*

1.2 NARRATIVE OF EVENTS – VESSEL AND TBNC

(17) "On board *Sand Kite*, meanwhile, the able seaman watchman visited the bridge and reported the results of his cargo measurement. *He was asked to call the bosun and stand-by. This was around the time that the Sand Kite was manoeuvring to overtake Thames. After the junior mate had gone below to his cabin.*"

(32) "Meanwhile the TBNC VTS operator had noticed that *Sand Kite* was to the north of the normal approach track and indicated this to the duty marine officer who called *Sand Kite* on VHF at 0647 to ask whether she could see the barrier's lights. *The mate replied that he could see the span. The master had, by this time, taken the helm of the Sand Kite. At no time, before making contact, was the span itself visible, as the mate's response may suggest. Due to the poor visibility, only the fog light of the northern pier was seen with any consistency.*"

(33) "Realising he was offset to the north and closing the barrier, *the master immediately relieved the mate at the wheel and operated hard to port, before increasing propulsion to full ahead. The vessel started to swing but it was too late to avoid contact with the unfendered concrete, of Pier 5.* Just prior to the impact he ordered the mate to put the engines full astern and the bow thruster to port.

1.6.2 Wheelhouse Layout and Equipment

(1) "On the forward bulkhead of the totally enclosed wheelhouse (**Figure 11**) is a wide central console unit which houses the main navigational and control equipment. On the port end of the console are two data recording instruments which are interlocked with dredge control functions, so that basic navigational information including time and position are recorded during dredging operations and were not recording at the time of the accident. The main steering position is sited centrally on the console enabling the helmsman to have a good view forward (**Figure 11a**). The autopilot is mounted just to port of the main wheel. A computer visual display unit (VDU), which is also sited to port of the steering position, is capable of showing rudimentary maps that have been drawn by the vessel's officers. A differential global positioning system (DGPS) input to the computer enables the vessel's current position, course and speed to be displayed on the VDU overlaid on the map (**Figure 11b**). *The overall accuracy achieved by the unit is good, giving the helmsman a quick indication of the vessel's position and course made good, in relation to the river banks, as well as geographical location within the river itself. However, details such as jetties, mooring buoys and the barrier, were not represented on the display. Thus limiting its contribution to the final stage of the pilotage.* To starboard of the steering position are engine controls and, at the starboard end of the console, the main VHF radio and Kelvin Hughes HR2044 radar. Another radar, a Kelvin Hughes Nucleus 5000R, is mounted at the end of the console on the port side of the wheelhouse (**Figure 12**)."

2.2 BRIDGE TEAM ORGANISATION

(5) "Due to the poor visibility on 27 October, the mate on the helm was reliant on directions from the master. He had no direct sight of a radar *although the VDU display provided information about the vessel's position and course made good.* The master's attention was focused on navigation and giving helm orders to the mate. Additional responsibilities

included monitoring the VHF and maintaining a lookout and performing the more general functions in his capacity as both master and pilot. As the demands of an individual's workload increase, the standard of performance typically increases until an optimum level is achieved. If this is exceeded, research shows that important information will be missed due to the focusing of attention on to a narrow range of functions.[1] The evidence in this investigation reveals that the master failed:

- *to appreciate that the barrier fog lights had an effective range of 0.2 miles, or less. However, he had not been prepared for this, either by Thames VTS reports or by his own previous experience of the river;*

- to ensure the lookout was posted forward before the Woolwich Ferry;

- to appreciate that his order to "come slowly to port" was insufficiently precise bearing in mind the helmsman had little or no other information; and

- *to assess, from the radar information, that the ship was drifting to the north of the intended track."*

(6) "Although the watchkeeping seaman was used as lookout for the first part of the river passage, *he was sent below to prepare the moorings for berthing and measure the cargo* when the vessel reached the end of Gravesend Reach. Notwithstanding the explicit instructions in both the master's and the company's standing orders that a lookout was to be posted, *the master considered that he was able to act as lookout. Since, the radar's effectiveness had been assessed, visibility had improved and the last of the channel buoys (particularly poor radar targets) had been passed. In addition, past experience assured him that Thames VTS would keep him informed of navigational hazards ahead.* Even the presence of another vessel about half a mile ahead of *Sand Kite* was insufficient to persuade the master to keep the designated lookout. From that time, the mate, in addition to steering the vessel, *provided unsolicited back-up to the master, as lookout, pilot and VHF watchkeeper.* When the vessel made her final approach to the barrier, the senior mate, who was a PEC holder for the river area to Angerstein's Wharf, was being used as helmsman and lookout which prevented him fully contributing to the navigation of the vessel. This was not the best use of his expertise and left the vessel exposed to any navigational errors or misjudgements that the master might have made."

(7) "Because they may have been out of practice, the master had no confidence in the general ability of the watchkeeping seamen to steer the vessel well. On vessels equipped with autopilots, many of which have tillers instead of wheels, hand steering is very seldom used. *During the eleven days of his first full voyage as master,* he had discussed the seamen's steering ability with the mate and established, in common with other ships of his experience, that they were not generally used as helmsmen. He had intended to follow-up this discussion but had not done so prior to the accident. This was a serious shortcoming on *Sand Kite*. Where minimum numbers are employed to operate a vessel it is essential for each person to maintain the basic skills of his job. Had the master been able to rely on the steering skills of the seaman watchkeeper he would have had greater flexibility in organising his bridge team."

2.3 NAVIGATION

2.3.1 Speed and Separation in the River

(2) "As the vessels approached the barrier control zone, the master of *City of Westminster* reminded *Sand Kite* that his vessel would be berthing just down river of Angerstein's Wharf and invited *Sand Kite* to overtake *City of Westminster* "in Woolwich Reach or something – if that's what you'd like" (**Annex**). In good visibility it was a reasonable action to propose and execute except that overtaking between the barrier and Woolwich Ferry without specific permission from TBNC is contrary to bye-laws. *Sand Kite*'s master had previously sailed with the master of the *City of Westminster* in a subordinate capacity and held him in high regard. This, and the fact that he was new to his own command may have contributed to his decision to agree to the manoeuvre. *It is apparent that he had not planned to overtake the City of Westminster at this time. However, the VHF message indicated that she was already reducing speed. Whilst his conversation with the vessel, at 0619.50, had made the master aware of the hazards involved in following the City of Westminster. Since she was to be swung 180 degrees, right across the river, before berthing head to tide. Sand Kite* overtook *City of Westminster* in Gallions Reach and this became, in retrospect, a contributory factor in the subsequent accident."

(4) "The relatively high average speed and overtaking manoeuvres carried out by *Sand Kite* and others in the conditions of poor visibility reflects the confidence masters have in the ability of VTS to warn them of *navigational hazards and visibility ahead.* They knew, for instance, they would not meet any opposing traffic without warning. Meanwhile their radars would give them early warning of small boats and ferries."

2.3.2 Approach to the Barrier

(2) "During the final approach to the barrier the master had, apparently, remained convinced he would sight the fog lights in time to assist with lining up the vessel in the middle of the span. A vessel that had transited the barrier a little earlier had reported to Woolwich Radio she had first seen the lights at a range of 0.2 miles. Additionally *Arco Beck* had told *City of Westminster* that she too had first picked up the lights at 0.2 miles. Both these reports were transmitted on VHF Channel 14. It appears the master of *Sand Kite* was either so preoccupied with the navigational situation he either did not hear them, *his attention was being focussed only by Woolwich Radio transmissions, or the information was not received clearly by the ship's VHF set.*"

(7) "The master expected to see the lights in time to navigate by eye through the barrier. By the time he realised this was not going to be possible, it was too late. The master's ability to conduct blind pilotage safely in *Sand Kite* is questionable. He had neither *practised nor received the visibility information, that would have enabled him to prepare for it,* had left himself short of manpower and was trying to do too much himself. He was also going faster than he had planned. Effective blind pilotage needs constant practice. Ideally it should involve bridge resource management and simulator training. It should be routinely exercised in clear weather conditions so it can readily be introduced when required."

(8) "Transits of the barrier by vessels the size of *Sand Kite* are not barred due to lack of visibility and, in the opinion of the Inspector, there is little reason to suggest such a restriction should exist. *Vessels the size of the Sand Kite should be able to safely navigate through the barrier if they are properly equipped, manned and efficiently navigated. However, the level of performance, in equipment, ship's staff and navigation, is crucially, dependant on the reliability and quality of information received.* Owners, masters and the PLA as appropriate must ensure these criteria are met in all cases."